CHEMICAL & METALLURGICAL ENGINEERING

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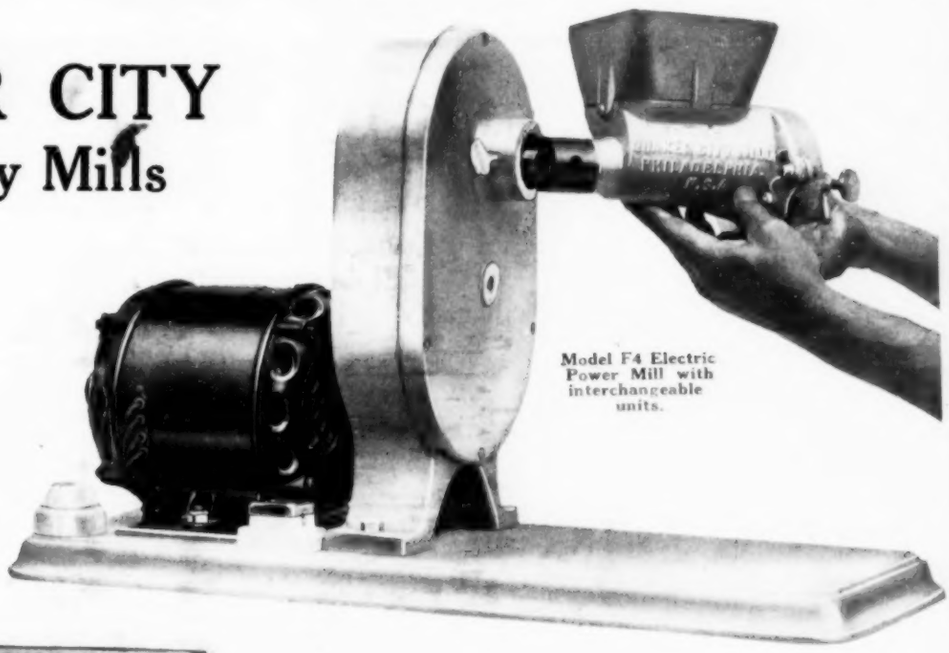

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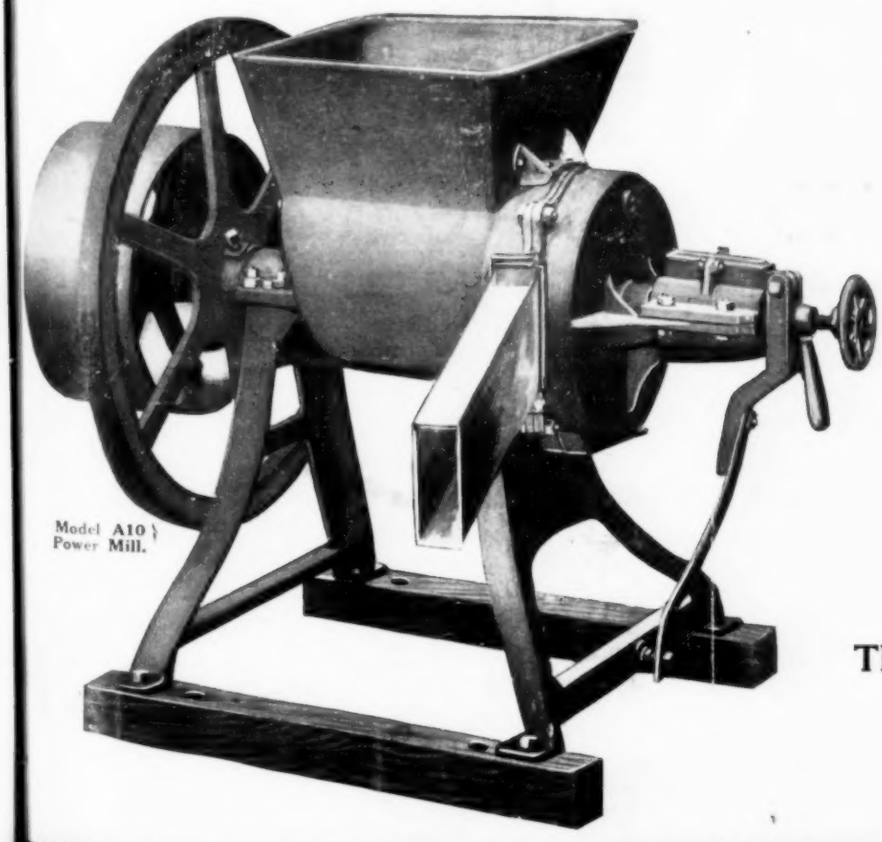

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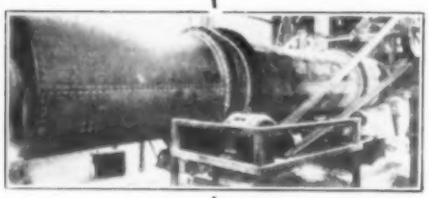

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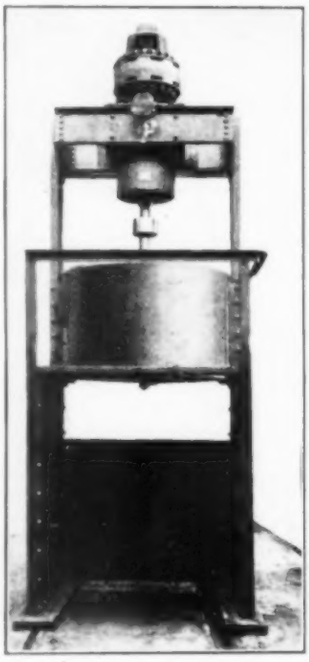

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A consolidation of
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The Report of the Industrial Conference

THE report of the Industrial Conference called by the President, issued a few weeks ago, apparently has received little public comment despite the fact that it offers a definite plan for the prevention of disputes and adjustment of differences now so prevalent in industry. This Conference was more successful than its predecessor, which was disrupted when Mr. GOMPERS withdrew with the representatives of Labor. The failure of that first Conference was inevitable because the groups composing it were directly interested in securing official recognition and adoption of partisan policies which were already bones of contention in industrial relations. Further, the proceedings were public. There was too much incentive to play to the galleries, and unyielding partisanship finally wrecked a hopeless attempt to formulate a constructive program.

The second Conference seems to have been more rational in its organization and procedure, and its report gives evidence of calm study, sober second thought and freedom from partisan hysteria. An effort has been made to gather facts, to learn from practical successful experience, and to formulate general policies, leaving the details to be worked out in accordance with the peculiar conditions surrounding individual industries.

For preventing industrial strife the plan which the Conference indorses is to secure co-operative effort through a "joint organization of management and employees." The Conference would prefer to "diminish the field of arbitration and enlarge the scope of voluntary settlement by agreement." And since the form of employee representation may vary in every plant, the subject "is not a field for legislation," but for local adoption and individual administration. "The strategic place to begin battle with misunderstanding is within the industrial plant itself."

The Conference is led to support the general proposition of a joint organization of management and employees because it finds that wherever such organization has been "undertaken with sincerity and good will" it has a record of success. This successful experience, the Conference believes, "is more useful than the views of extremists on either side." In case co-operative effort is not successful in reaching a collective agreement in any particular case, the Conference proposes a system of settlement through three bodies: A National Industrial Board, Regional Conferences and Boards of Inquiry, all under "governmental encouragement." "The entrance of the Government into these problems should be to stimulate further co-operation."

Opposition to the idea of employee representation is found by the Conference in two sources. On the one hand is the unprogressive and unenlightened employer, whose tribe fortunately is decreasing, who still regards labor as a commodity and who balks at any form of co-operation with his employees. On the other, there is the narrow trade-union leader who looks upon shop representation as something inimical to the union and likely to supplant its authority. As the Conference points out, however, the distorted view of the employer is rapidly disappearing, and the fear of the labor leader is based on a misconception of the relations between shop committees and unions, which are in fact complementary. "Local problems fall naturally within the province of shop committees. No organization covering the whole trade and unfamiliar with special local conditions and the questions that come up from day to day is by itself in a position to deal with these questions adequately."

The Conference recognizes fully that "employee representation offers no royal road to industrial peace. . . . It is only a means whereby sincerity of purpose, frank dealing and the establishment of common interests may bring mutual advantage." Too much stress cannot be laid on the prerequisite of sincerity of purpose in putting such a plan into effect. It is the cornerstone of all institutions involving human relations, for suspicion will defeat the ends of ideal plans. In view of the fact that the Conference discovered enthusiastic approval among employers and employees who have had experience with co-operative effort, we may accept its recommendations as representative of both parties in industrial relations. And as for the proposed system of settling disputes not agreeably disposed of through collective effort, it seems worth a trial, since "its basic idea is stimulation to settlement of differences by the parties in conflict, and the enlistment of public opinion toward enforcing that method of settlement."

A "Carnival of Greed and Imposition"

ELBERT H. GARY has been chairman of the United States Steel Corporation since its formation nineteen years ago, and has had occasion to make many public utterances, which have obviously been delivered only after careful consideration. In no such utterance has Judge GARY ever used intemperate language, and rarely has he used what might be denominated "strong" language. He has a way of having the thought expressed stronger than the language used in its expression. When, therefore, in his formal address at the recent annual meeting of the stockholders of the corporation Judge GARY referred to there being a "carnival of greed and imposition," the expression must be taken as representing a very strong conviction upon an extremely undesirable state of affairs. Judge GARY felt it to be everyone's duty, even at some personal

sacrifice, to help check the carnival. The United States Steel Corporation has been doing what it could, by continuing to sell its steel products at the March 21, 1919, prices, set by the medium of an agreement between Secretary REDFIELD'S Industrial Board and representatives of the iron and steel industry. For months past consumers of steel have been bidding higher prices and the independent producers have been asking and accepting higher prices, sometimes very much higher prices.

There are several reasons why sellers should endeavor to hold prices down in a time like this. One reason is that great injustice is worked by advancing prices, as Judge GARY clearly pointed out, to those with more or less fixed incomes, like salaries, for in essence such people are paid in a depreciated dollar.

Another reason, more or less selfish, is one that does not concern the United States Steel Corporation, since it is self-contained. That is that when a manufacturer advances his selling prices those who sell his raw materials to him are likely to advance their prices, and the manufacturer cannot "get away" with all the extra profits his own price advance seemed to assure him. It is recent history how the merchant blast furnaces greatly advanced their pig-iron market, whereupon the Lake Superior iron-ore producers advanced their ore prices and the Connellsville coke producers advanced their coke prices. The merchant furnaceman has no assurance that his advanced pig-iron market will last as long as the advanced ore and coke markets.

A third reason for holding prices to a safe and sane basis is that "whatever goes up must come down." When prices come down, usually somebody gets hurt. The proper course of business is certainly disturbed. We want to make progress, and efficiency in making progress requires that there be steady markets and uniform conditions, so that men can plan ahead and build ahead.

When there has been a great disturbance unpreventable by business interests, such as the late war, business should protect itself from the after effects. When the Great War closed there was a disposition to look at the course of industry and markets after our Civil War to see if some light might not be secured. It was unsafe then to conclude that conditions had much in common, but at this time, nearly a year and a half after the Armistice, evidence has accumulated that there is no small degree of similarity. The similarity is not a synchronism, but one should not ask for time similarity, since a month nowadays does not mean the same compass of business experience as it did over a half century ago, in the post-Civil War times. The history of that time was that after LEE'S surrender, April 9, 1865, ending the Civil War, pig iron declined for a few months, approximately from $48 to $35, then advanced to $51, a higher price than obtained at the end of the war, and then declined again. The second low point fell thirteen months after LEE'S surrender. We are slower in these days, or our business is more ponderous. There were five clearly marked round-trip swings in the pig-iron market before the continued decline set in during the great industrial depression of 1873 to 1878. It seems reasonable to assume that the fluctuations were disadvantageous to business, just as wide fluctuations are today.

If anyone assumes that prices can be pushed up and held up long enough to prove profitable, as compared with conditions under a stable and reasonable market, he is probably wrong. The worm will turn. If he assumes that there is only one advance possible and that on the basis of enlightened selfishness as much as possible ought to be made out of the advance, he is probably wrong again. Prices pushed too high eventually decline too far, and then they advance again. The present is not the last chance that is going to be afforded this generation to make money.

Either on the basis of reasonable regard for the general good or on the basis of enlightened selfishness the course dictated is that of moderation in the naming of prices for commodities or charges for service. The "carnival of greed and imposition" is probably a psychological reaction from the war-time sacrifice and co-operation. Instead of continuing the good work, we have had a reaction.

Testing High-Speed Steels In the Small Shop

A CASUAL reader may wonder just how "metallurgical engineering" can be stretched to cover the subject of lathe tools. But the metallurgist in the progressive manufacturing establishments of today realizes as keenly as does any confirmed efficiency expert the need of dependable, uniform quality of tools, and it is ordinarily he who puts the most thought and care upon them. As long as a fairly good tool is available in quantity, the men in the shop do not have much to say, but the metallurgist or heat treater is the first man to hear about any serious breakdown on account of tools. On the other hand, he is the man most actively interested in —one might almost say the only man continually seeking—a method whereby really superior tools may be secured for each class of work passing through the shop in large volume.

He has a continual problem, however, to determine to his own satisfaction whether a change in his practice will actually improve the efficiency of his product. Certain it is that relief may not infallibly follow a change in tool steels, for Major BELLIS quotes the Springfield armory as one shining example where attention to infinite detail regularly produces the most extraordinary rifle-barrel drills from mushet steel, which any salesman will tell you is obsolete, a relic of the dark ages, and even bolshevik to think about. Yet the same salesman would be hard put to make a drill from his pet brand which is half as good; perhaps BELLIS could do it, given time, but the salesman certainly not.

Inquiry among the mechanics, tool room men and shop foremen as to what they "think" of a certain brand of steel or kind of tool is admittedly a very insecure method of judging their real quality. Yet the metallurgist who has read FREDERICK W. TAYLOR'S monograph "On the Art of Cutting Metals" (and who has not?) will be so impressed with the almost overwhelming resources needed to test the efficiency of a particular tool in TAYLOR'S exhaustive manner that he will realize its impossibility of widespread application. Yet some accurate, experimental basis is essential for progress.

Mr. LANGHAMMER'S articles commencing on page 829 of this issue have within them the potentiality of enormous advance in tool steel practice, simply because they point out how the metallurgist, tool man and heat treater in the thousands of progressive but small shops may continually improve their methods with a corresponding reflection in the total costs. Of course, a large volume of ideally uniform material to be cut is seldom available

sufficient to compare so large a number of tools as did the Packard company. But the problem before the smaller shop is not so much whether they should change their brand. In fact if they are securing their stock from one of the American tool-steel makers whose every effort is for a quality product, they had far better turn a deaf ear to the persuasive salesman and attempt to develop the inherent possibilities of their regular tools. So their problem is much simplified. It is merely this: Will this small change in one detail of hardening-room practice, or tool-grinding practice, or any one of the dozens of factors responsible for a good steel, *actually improve the tool?*

It is only necessary to make up carefully two sets of, say, six tools each; one set by the standard method and the other set by the revised method, reference them by complex code markings, lay them aside and forget the code. Then watch the work going through the shop, and some day when a long job appears, carefully inspect the rough metal to be worked and select enough of it for its uniformity to cause failure in the dozen prepared tools in both first run and after regrinding. Put this work on a first class machine, work out correct conditions of operation as explained by Mr. LANGHAMMER, do the work with most careful, conscientious workmen, and make a correct log of the run.

At the end you will have something more than "opinion" to tell you whether it is better to draw from 1,100 or from 1,050.

Research Among The Bakers

THE American Institute of Baking, the first child of the National Research Council, if we are not mistaken, has duly appeared in Minneapolis, and, to judge by its first bulletin, it seems to be of requisite weight, to have lusty respiration, to possess the right number of fingers and toes—in short, to be a promising infant. Dr. H. E. BARNARD is the director, and his name gives confidence in the wisdom and scholarship of its management. It has found asylum with the Dunwoody Institute, a continuation school in Minneapolis, and here the American Institute of Baking will maintain scholarships and provide for six months' courses for bakers against the payment of fees, as well as conduct research and give consultation to its members. The president is GORDON SMITH of Mobile, Ala., and the secretary is DR. P. CHISHOLM, of Chicago.

Here is a chemical industry that has not known itself as such. It is ancient of days, replete with traditions, and complete knowledge and understanding of the art was supposed to be well-nigh universal. In fact, some of us who can hark back a generation or more recall the sage advice not to marry a lass unless she can bake a loaf of bread—and bake it well. If there was any place where the chemist was not wanted it was in the bakery—and save in rare exceptions he stayed away. The Research Department therefore finds itself confronted with chemical, physical and biological problems in remarkable number. They are complex as well as numerous, and, in the words of the bulletin, "The selection of any one of them will lead to many unknown investigations, the nature and value of which cannot be predicted. Some of these subsidiary problems may be of practical value and others may have for the present but the interest of a problem in pure science." Among the immediate projects are: The determination of moisture retention in bread and the prevention of staleness, the study of sweetening agents, shortening agents and their effects on fermentation, the activation of ferments to expedite rising, development of control tests for bakeries without laboratories, and, in co-operation with other laboratories, the study of standard and uniform methods of analysis of flour and other baking materials. In addition to these are questions of flavor, yeasts and yeast-foods to be determined—and all this is merely a beginning.

The technical and service department will offer to bakers the rapid solution of momentary difficulties and supply information on technical or chemical questions. The baking laboratory is prepared to make bread by almost any method of procedure, and an engineering bureau will give attention to questions of building construction, power, heating, ventilation, wrapping, etc. It is planned to make chemical surveys of stocks of raw materials and to keep a watchful eye for fraud and upon nostrums that are offered to the trade.

A questionnaire is included in the bulletins to which members are invited to reply. We venture to predict that the answers to question No. 8 will be an index of the scientific measure of the minds of the bakers who compose the organization. It reads: "What is your formula for the bread which is your best seller?" We wonder how many bakers there are who have enough scientific understanding to know that it will do them no harm to tell? Or that thousands of others know as much of the technique of baking as they do? Or that, scientifically considered, they are still outside the portals of knowledge? Or of the delectable gardens of profit that are available to the *cognoscenti*?

Availability of Nitrate And Ammonia Nitrogen

IN ACCORDANCE with a policy outlined in these pages some time ago, a thorough survey is being made of the fixed inorganic nitrogen industry. During the controversy over the proposed Government operation of the Muscle Shoals plants, a question has been raised which seems to be of fundamental importance in a consideration of the fixed inorganic nitrogen situation. This concerns the relative availability of nitrate and ammonia nitrogen.

This is, of course, a problem in plant metabolism, and we must turn to the agricultural chemist for reply. The commonly accepted view is that nitrate nitrogen is immediately available for plant use, while ammonia nitrogen becomes available only after it has been oxidized to nitrate by the action of certain micro-organisms in the soil.

No classical study has been concluded giving the soil and temperature conditions under which the nitrifying bacteria function. Before the days of Chilean saltpeter, almost every farm in Europe had its niter leaching bed, but the temperatures were high in these due to the heat of fermentation. Such favorable thermal conditions are seldom encountered in the present-day application of inorganic ammonium salts. This is especially true in the more northern localities. Here exists an opportunity for the bacteriological and agricultural chemists to co-operate in the isolation and study of these important bugs. The development of a more hardy type having a thermal range of activity coincident with that of plant life is not beyond the bounds of possibility.

British Chemical Industry

(From Our London Correspondent)

London, April 7, 1920.

THE past month has not been distinguished by any outstanding feature of interest, but the flood of new capital issues has practically ceased, probably because the uncertainty of the international and financial situation has made it more difficult to make underwriting arrangements. The chemical industry, which in the past has been singularly immune from difficulties arising out of strikes and labor unrest, is now passing through a transition period in which successive demands for increased wages and better conditions are being made by the workpeople. It is difficult, if not impossible, in some cases to improve the somewhat unpleasant conditions of labor obtaining in chemical factories, and on the whole grievances of this kind are being successfully met. The question of wages is proving a more difficult proposition, chiefly because the workmen's delegates are adopting the policy of making fresh demands as soon as possible after agreement has been reached on a previous claim. In the result much time and effort on the part of the executives are being wasted which could be more profitably utilized.

In the chemical trade demand still exceeds supply, especially for export account, and prices therefore remain steady and firm. Bleaching powder is practically unobtainable, and there is evidence that attempts are being made to create a temporary monopoly in cream of tartar, which is talked up to £400 per ton, as against the present price of about £300. It remains to be seen whether the increasing use of substitutes, such as acid phosphate of calcium, will have a deterrent effect, but until fresh supplies become available after the summer the outlook in this and kindred commodities is somewhat obscure.

Colloidal Fuel Development—Sugar Industry—Prospects for Synthetic Indigo

An interesting new issue is the Liquid & Solid Fuels Co., Ltd., with which, it is understood, the Duckham and Anglo-Persian interests are to some extent identified. It is rumored that this company is to exploit the patents of Lindon W. Bates and his associates, who, it will be remembered, did such valuable work for the Submarine Defense Association of America during the war. It is thought that there will be a vigorous development in the colloidal fuel field, possibly in conjunction with the provision of bunkering stations on the trade routes supplying colloidal fuel to ocean-going steamships instead of fuel oil. The position is somewhat obscure at present, as the patents have not yet been published, but it is known that there are other workers in the field in regard to suitable "fixateurs," so that in a few months' time the position should become extremely interesting. As the British Government has a large interest in the Anglo-Persian Oil Co., the problem is likely to become a national one, while at the same time industrial users are not overlooking the possibilities of this new fuel.

Another industry which is attracting increasing attention is that exemplified by Home Grown Sugar, Ltd., which, under government auspices, is to establish the beet sugar industry in Norfolk. The production of sugar within the British Empire was the subject of a report to the Society of Chemical Industry published in its *Journal* of Aug. 15, 1919, and while some years must elapse before definite results are available, it is hoped that this move will have a stabilizing effect upon the upward trend of sugar prices in this country.

The Indian indigo industry is again attracting attention as a possible competitor of synthetic indigo, a curious reversal of the situation at the time when the synthetic manufacture was perfected in Germany. The prospects of the industry are stated to be increasingly favorable since scientific investigation and methods have been applied and it was found that the use of phosphate fertilizers greatly increased production, while the alkaline action of the cement-lined tanks had an adverse effect on yields. Natural indigo is a more effective dye than the synthetic product, probably because it contains ingredients other than the indigotin which is its main constituent and is the pure material made by the synthetic process.

Trade and University Activities

The projected association of merchants, in which the lead is being taken by the larger and old-established firms, is expected to take definite shape very soon, but it is still a moot point whether an entirely new organization is to be created or whether an amicable arrangement can be arrived at with the existing British Chemical Trade Association. In this case it is interesting to note that the honorary secretary of the latter body, S. J. C. Mason, who represents an American firm, has resigned, and the assistant secretary, O. F. C. Bromfield, has been appointed to succeed him. The position is somewhat similar to that of a trade union for any particular industry, as only one such trade union can be registered. Similarly, the British Chemical Trade Association has been recognized officially by the government authorities, and an interesting situation may therefore arise if it is decided to form a new body instead of going to amalgamation.

The appeal for funds of Manchester University has taken a form akin to a company prospectus, applications being invited for shares carrying no dividends, and it would seem that "conservative" Manchester is taking a leaf out of the American book as regards its method of publicity and giving a not unwelcome lead to others.

It is understood that Brunner-Mond are not acting alone in their purchase of the Billingham nitrate factory and the acquisition of a nitrogen monopoly, but that other heavy chemical interests such as Explosives Trades, British Cellulose, etc., are concerned.

Research Work Encouraged

Colonel A. W. Crossley, who did valuable work during the war at the poison gas experimental station near Salisbury, has left his professorship at King's College to take up the position of director of the British Cotton Industry Research Association of Manchester and about $1,000,000 is to be spent upon a research institute under his guidance.

Of more than passing interest is the transfer of the director of the British Photographic Research Association to one of the largest chemical firms, the change it is understood, having been made on condition that a transfer fee was paid to the funds of the Association. This arrangement seems to be without precedent—always a fetish in British national life—and, together with the incipient absorption of academic men in industry owing to its superior financial attractions, may be regarded as a sign of the times.

A Comparative Test Upon High-Speed Steels—I

Notes on a Competition of Modern High-Speed Steels Conducted for an Automotive Manufacturer—Preliminary Observations on Current Sales Practices and a General Review of Various Classes, and the Effect of Chemical Compositions and Heat Treatment

By A. J. LANGHAMMER, M.E.*

IN THE last sixteen years the use of high-speed steel has grown from practically a metallurgical and manufacturing experiment to what is today one of our most important economic and industrial factors. The principal reason for its wide application is the rapid growth of quantity production methods, as applied particularly to the automobile, machine tool and allied industries, and the introduction of scientific management in these works.

Today there are dozens of brands of American-made high-speed steel on the market, and in the last eight months some of the famous English brands have again made their appearance. British-American brands too are very much in evidence, particularly in the crucible mills. Both electric-furnace and crucible steels are well represented, though the latter is still very much in preponderance.

Salesmen's Methods

High-speed steel selling methods of today leave very much to be desired. In general, the steel is sold by voluble salesmen who know nothing of their wares, have never been in a steel mill, and have never graced the floor of a machine shop. Fortunately, there are always some saving exceptions. It is indeed astonishing how little the average steel salesman knows of his product. If an interview is granted him, he begins by nonchalantly announcing that his brand is the best in the market, and that he can increase your production anywhere from 50 to 100 per cent, or more. When pressed for supporting data, he refers you to a local machine shop or some large manufacturer out of the city. During the war, Government plants and arsenals were quoted elaborately as using solely their steel. If you took the trouble to investigate, it would invariably develop that the particular brand in question had never been used, or that a small sample had been left gratis by the salesman for test purposes. Usually the test disclosed a mediocre or even a poor steel. The damage done to the steel company by such misrepresentation is almost immeasurable, for though it may later improve its product or even bring forth a superior brand, you still retain that bad taste from the interview and are suspicious, if not antagonistic.

Sometimes you meet in steel salesmen a canny old-time mechanic who has forced his way into the selling business and who is wiliness personified. If such a man is permitted to have a hand in directing the test, and the man in charge of the test is not himself an expert, then the result is never in doubt. The steel that the "old-timer" represents will win out.

High-speed steel salesmen often have access to a supply of specially-prepared steel for test purposes. At the mills a heat may be prepared which has the best possible composition and subsequent workings and heat treatments are very carefully performed. When this practice is not followed, a batch of "regular run" steel that has shown exceptional performance under test is retained for test purposes only. Obviously, when the steel company begins to fill orders, it will ship from the regular run of stock, which is inferior in quality to the "special" bar submitted for test purposes. In justice to the steel manufacturers it must be said that such practices seldom or never reflect the true policy of the companies represented (or misrepresented).

Most steel companies, too, manufacture several grades of high-speed steel. One of the grades is usually superior to all of the others and is the best steel that experience and careful manufacture can produce. This steel is then used for test purposes and should it win a place when the final selection is made, great care must be exercised to see that the "best grade" is received on subsequent shipments and not specimens of the poorer grades.

High Cost of Cheap Tool Steel

Much is found wanting in the average buyer or specifier. In most plants the purchasing agent decides on the brands, and he is naturally gullible on this subject. His decision is usually based on price, which to him is all important, while in reality it constitutes practically a negligible item. Then, too, if market conditions seem to warrant, as they do in recurring stress periods, he will buy as much high-speed steel as he can and of every available brand. In this way his errors are multiplied, for not only does he get steel which is primarily poor, but also such rejected stock as has been accumulated by the steel salesmen.

Under modern manufacturing conditions it is of utmost importance to know the comparative capabilities of the various brands of high-speed steel on the market. This applies to the small machine shop as well as the giant works. As stated above, the first cost of the raw material in a high-speed tool is practically negligible. This is true because the labor cost for the machining of such a tool is usually several times that of the raw material. Also, when a tool is made up of an inferior grade of steel, it may be scrapped after an attempt at hardening before it ever gets into the shop, thus producing an immediate combined loss of indirect material, labor and overhead. If the tool should successfully pass through the hardening room and subsequent inspection into the machine shop, trouble at once begins. Production is decreased, more work is incurred for the machine operator and tool grinder due to the increased tool changes, and costs increase accordingly. Spoilage or scrap also takes a jump and the costs increase again.

When the capabilities of certain brands of high-speed

* Industrial engineer, Thompson & Black, engineers and accountants, New York and Detroit.
Formerly mechanical engineer, Packard Motor Car Co.

steel are to be determined, it is imperative that the test be conducted under the constant supervision of a competent observer. This man need not be a technical graduate, but he should be a good mechanic and in addition he must possess the mental and moral qualities that permit him to follow instructions explicitly. The man in charge of the test, however, must be familiar with all the variables that affect the life of a cutting tool. He can then correctly plan the complete details of the test which will be executed by his subordinates. Too much stress cannot be laid on the fact that the man in charge of the test must know all the variables that are factors in the life of a cutting tool. One of the reasons that large quantities of relatively poor high-speed steel are used annually is that such tests are conducted by incompetent men.

In addition to the objection to the use of a large number of miscellaneous brands of high-speed steel noted two or three paragraphs back, there is that of difficulty in heat treatment. A standard method of heat treatment is all-essential for uniformly good results. Mediocre or poor grades of steel do not in general permit high heats and must be treated accordingly. If the next tool is made of a good steel which must be subjected to a high heat for best results, the chances are very much against its proper hardening, and the result is confusion, increased difficulties, more work, and finally a general run of poor tools. When quantity production methods are employed, as for example in a cutter or twist drill plant, these bad conditions are considerably augmented.

With a selection of brands that permit a uniform heat treatment, the tool hardener has an ideal condition and his work will show results.

Tool Steels in General

Carbon Steels

Carbon tool steel, which was the earliest form of cutting steel used in machine shops by manufacturers, is now used only in relatively small quantities for its once popular purposes except in cutting non-ferrous metals and non-metallic materials. It has a wide and universal application, however, for hand tools such as chisels, punches, dies, shearing blades, cutlery, broaches, hand taps and reamers, etc. Large quantities of plain carbon steels are also used for forging dies, hammer dies and machinery parts, though in these instances elements that promote toughening, resistance to wear and shrinkage are usually added to the alloy. As a cutting tool it fails because of the low duty that can only be exacted and the premature dulling of the cutting edges.

Self-Hardening Steels

Mushet, or self-hardening, tool steel (so called from the name of its inventor) was the immediate successor of carbon tool steel. This steel usually contained from 6 to 9 per cent of tungsten, 2 per cent of manganese, and a high percentage (about 2) of carbon. With the introduction of mushet steel, cutting speeds were increased about 60 per cent, and this record stands out as one of the most notable achievements of that time, though not fully exploited. Today this steel is obsolete, but it was of extreme usefulness in that it formed an indispensable link in the development of modern high-speed tool steel. It is an obsolescent product because practice today demands a cutting speed far in excess of its capabilities.

High-Speed Steel

Self-hardening tool steel was the immediate predecessor of high-speed tool steel. The composition of the average high-speed tool steel (by actual analysis of sixteen different brands) is as follows: carbon, 0.60 to 0.70 per cent; tungsten, 16 to 18 per cent (although one or two brands go as high as 22 per cent); vanadium, 0.75 to 1.05 per cent; chromium, 3 to 4 per cent. In addition to these "standard" elements, some brands contain also uranium, cobalt, manganese and molybdenum. Sulphur and phosphorus average from 0.02 to 0.04 per cent and the same minimum amount of silicon is generally present.

High-speed steel enabled an increase of about 400 per cent in cutting speed over mushet or self-hardening steel. The feature wherein the tools made from this steel differ from and exceed in performance the tools from the preceding steels is their ability to maintain a sharp, strong cutting edge while heated to a temperature far above that which would cause "failure" or "breaking down" of the cutting edges on tools made of the simple steels. As a matter of fact, the sharp cutting edge is maintained until just a short time before failure occurs. Carbon steel tools, on the other hand, show wear or dullness of the cutting edge as soon as they are put to work. The heat generated by the friction of the chips on the tool when cutting steel, plus the pressure, is great enough to weld small bits of the chip to the tool at some distance (depending principally on the depth of cut) back of the cutting edge proper and to wear a groove into the lip surface. The property of being able to retain hardness and cutting ability at a red heat is termed "red hardness." In the early days, the principal objection to high-speed steel was the apparent inability to produce a good finish. This handicap was largely imaginary and not well founded, for in the general run of work no such difficulty is experienced.

Stellite

As self-hardening tool steel was supplanted by high-speed tool steel, so the latter will in some cases give way to stellite when this alloy is applicable. Stellite is made up of approximately 65 per cent cobalt, 25 per cent chromium and 10 per cent molybdenum. It is extremely hard, quite brittle and possesses the quality of red hardness to a very marked degree. On cast iron, stellite has a cutting speed of 100 per cent above high-speed steel, while on bronze it may run as high as 700 per cent faster. On soft steel, honors are about even, depending on conditions. Stellite, however, is not adaptable even to cast iron or bronze when the tool is subjected to sudden shocks, on account of its brittleness.

Much work is being done in developing both stellite and similar alloys, but to date none of the rival products tested by the writer have equalled stellite in performance or adaptability. The range of utility of stellite is greatly increased, due to the fact that small rectangular or square sections can be readily welded in an electrical welder to large steel shanks, which arrangement gives a high-duty tool of low cost. The same procedure, of course, is applicable to high-speed steel.

Cast Tool Steels

Within the last two years several very promising brands of "cast high-speed steel," both air- and oil-

hardening, have been produced in this country. In some cases the alloy has a composition very similar to that of a good brand of high-speed steel, while in others no tungsten is used. Distinct advantages are claimed which greatly reduce factory costs. Thus it can be cast readily into almost any intricate shape such as dies for presses, milling cutters, core drills, form cutters and other special high-duty working and cutting tools. These castings, which usually anneal readily and machine easily, require but a small percentage of machining as compared with the tool made from a solid bar, whereby the labor cost is reduced very appreciably.

When placed in actual operation, some of these tools have produced as high as ten and twenty times as many parts as a regular high-speed tool on the same task, with the consequent saving in costs. Milling cutters made of such cast high-speed steel have been seen by the writer in use, and their performance appeared to be excellent. In this case, however, the duty was not very heavy, though the cutting speed was high, so that too much importance could not be attached to the one demonstration. Cutters of such material and of intricate design were at once ordered by the author's firm, but to date they have not been tested. In view of the recorded successes of "cast" steel and the large amount of experimental work that is being done with them, developments of extreme importance can be expected in the near future. This is the more interesting because the idea of casting high-speed steel is diametrically opposed to one of the fundamental requisites of a good high-speed steel, which is that the ingots must be of sufficient size that the proper reduction in area occurs in the working with the subsequent refined structure and hardy constitution.

English Brands

English steel makers are doing a great deal of work on high-speed steel, supposedly in an effort to produce a superior grade. As their efforts are chiefly confined to securing a substitute for tungsten, their object is probably to produce a cheaper steel. Molybdenum (already exploited by American metallurgists and discarded) is understood to be the principal element that is receiving their attention. Cobalt, too, is being thoroughly investigated, although both these elements are at the present time more expensive than tungsten. One English manufacturer has actually brought out a so-called "tungsten-less" high-speed steel that is being offered at an unusually attractive figure. In an actual cutting test, when run against a good brand of high-speed steel, it proved a failure. There may be quite a market for such a product, however, where a cheap cutting steel is desired for limited performance, or even for general work on aluminum, brass, or such easily machined metals. Again, this steel may be vastly improved, thereby increasing its usefulness.

Influence of Chemical Composition

It has been the writer's experience that the analysis of a particular brand of tool steel is but an indicator as to its ultimate capabilities. By this is meant that just because a high-speed steel has 18 per cent tungsten and other elements in proportion, it cannot be classed as a good steel on this basis alone. If, on the other hand, the analysis shows the presence of but 10 to 12 per cent tungsten, and no other substituting element, then one can readily assume that it would be a waste of time and money to investigate further such a steel. Since, broadly speaking, analysis does not in any way guarantee the performance of a tool, it is a grave mistake to order or purchase high-speed steel on the basis of specified composition only, which unfortunately is practiced by some large manufacturing industries. During an efficiency test, one of which is later described, it was always our policy to impress carefully upon the steel men that to us, chemical analysis as such meant nothing except as an indicator; the final requisite was that subsequent shipments of high-speed steel duplicated or closely approximated the performance of the test specimen. This usually served a good purpose, for not only would the salesman instruct the mill to inspect rigidly the first large shipment that was sent, but he would emphasize this point from time to time, because he knew that the steel would be subjected to a "check" test and the performance would have to be good.

The qualities ascribed to the various elements contained in high-speed steel are as follows, it being understood when discussing one that the other requisite elements are present in proper proportion:

Tungsten

Tungsten has long been credited as being the most valuable element in high-speed steel. The principal characteristic is that with a moderately rapid rate of cooling from high temperatures tungsten steels are exceptionally hard, and this hardness is retained even when the steel is again heated to a high temperature, because it offers a strong obstruction to the various changes from austenite to pearlite. This element, too, is very heavy, its specific gravity being about 19.3, it apparently diffuses very slowly, and in addition it is the most infusible element in steel with the exception of carbon. It is these three factors that may cause considerable trouble, especially in the crucible process, if in charging the tungsten is not placed at the top of the mixture so as to counteract in a measure its tendency to settle. If this tendency were not counteracted, an ingot of irregular composition would result. Tungsten raises the strength of the steel and also the temperature of fusion.

Vanadium

The effect of vanadium is to increase the hardness or red-hardness of cutting tools and also the resistance to wear. It has a strong affinity for oxygen and therefore probably acts to good advantage as a purifier. Vanadium greatly increases the strength of steel up to a certain percentage, though this limit is usually exceeded considerably in high-speed steel to get the effect of red-hardness.

Chromium

The effect of chromium in high-speed steel is to increase the hardness or red-hardness and also the life of the cutting edge. It also adds strength and especially toughness, thereby increasing the ability of the tool to withstand shocks and sudden strains. European steels, due presumably to their relative cheapness, use as high as 10 per cent of chromium.

Molybdenum

The use of molybdenum as a major constituent has in general been discontinued. High-speed steel with a goodly proportion of molybdenum is generally characterized by irregular performance, which is said to be due

to the ease with which it is volatilized. Such tools too often exhibit a tendency to crack in quenching. In general, molybdenum possesses the same quality of producing red-hardness as tungsten, though in a greater magnitude—possibly two or three times as great. This advantage is apparently lost almost entirely by reason of its instability, especially after re-hardening. However, European makers are now advocating the use of a relatively high percentage of molybdenum as a substitute for tungsten.

URANIUM

To uranium is generally attributed the quality of increasing the red-hardness, ability to withstand shock and resistance to wear. It is also a powerful agent for removing gases, principally oxygen, nitrogen and their compounds. This element, however, apparently exhibits characteristics which call for careful mixing and expert handling at the steel mill. It appears, too, that the electric furnace is most adaptable for the manufacture of this steel.

COBALT

To cobalt is usually attributed the quality of being able to cut extremely hard steel. It is generally conceded that an excess of cobalt produces a premature deadening or softening of the cutting edge. American manufacturers are apparently using little or no cobalt at present, probably due somewhat to its high cost.

MANGANESE

The effect of manganese in high-speed steel is to strengthen or toughen the body, at the same time allowing it to be worked readily. Apparently the effective range is very close, and when this is exceeded, excessive breakage results. It is believed that chromium is in general substituted for manganese.

TABLE I. MAKER'S RECOMMENDATIONS FOR TREATING LATHE AND PLANER TOOLS

Brands	Pre-Heating Temperature, Deg. F.	Hardening Temperature, Deg. F.	Quenching Medium	Drawing Temperature, Deg. F.
1	1600–1650	2250–2300	Oil until black, then cool in air	800–1000
2	No mention	Heat nose until it sweats, then quench quickly.	No mention	No mention
3	No mention	About 2300	Cool in air blast until nose is cold	No mention
4	Bright red	2250	Tempering oil	1000–1100
5	1700	2300	Lard-linseed or fish oil	400–600
6	1500–1700	2150–2400	Oil or air blast	No mention
7	No mention	About 2200	Air blast or oil	Draw when necessary
8	Red heat	2200–2250	Air blast or oil	500–600; 100–1100 for toughness
9	1400	2200–2300	Air blast or thin oil	700–750
10	Red heat	About 2300	Air blast or oil	No mention
11	1400	2200–2300	Thin oil or air blast	700–750
12	1375–1450	2250	Oil or air blast	500–750
13	1400	2300	Oil	1065
14	1500	2200–2300	Cottonseed oil	No mention
15	1400–1500	2250–2300	Oil or lead	1050
16	1400	2200–2250	Oil or air blast	No mention
17	1450–1550	2150–2250	Oil or lead	When necessary
18	No mention	About 2300	Fish or tempering oil	650 1130
19	Cherry red	White heat	Oil	No mention
20	Bright red	Melting or running point	Air blast	No mention
21	1750–1850	2250–2300	No mention	No mention
22	Cherry red	White sweating heat	Oil	No mention
23	About 1400	2200–2300	Air blast or thin oil	700–750 in lead
24	No mention	Slowly to 2100	Air blast	No mention
25	No mention	2300	Air blast or oil	None required

CARBON

Carbon is the element which forms the basis for all steel hardening and is a requisite constituent. In high-speed steel it is usually present in smaller amounts than would produce satisfactory results in the hardening of simple steels. This element in high-speed steel acts in a somewhat different way from what it does in the simple steels. In high-speed steel some of the carbon unites with the tungsten and chromium to form carbides of these two elements. The carbides in high-speed steel, especially tungsten carbide, are more insoluble than the cementite of the carbon steels and therefore, for hardening, a much higher temperature must be resorted to. The effect of carbon in connection with the various elements discussed above is beyond the scope of this work and will therefore be omitted.[1]

INCONSISTENCY OF RECOMMENDED HEAT TREATMENTS

The uncertainty of heat treatments recommended by steel makers is responsible for a great amount of cutting tool troubles and very much more accurate data should be forthcoming at an early date. This is especially true of the better steels. Precise information as to the proper time-temperature factor required for forging, pre-heating, heating and hardening, and drawing, at least, should be given. Variations for tools of different duties should be provided. Quenching mediums, "drawing mediums" and the time required for these operations should be given careful consideration.

To illustrate this point, the specifications of about twenty leading makers of steel (the majority of whom were represented in the test to be described later) are listed in Table I, and attention is invited to the apparent uncertainty in a large number of directions. For the sake of simplicity only the pre-heating, hardening and drawing temperatures plus the quenching mediums specified for "lathe and plane." tools are given.

(Part II will be published in our next issue.)

Automatic Gas-Analysis Apparatus for Government Helium Plants

S. F. Pickering, one of the members of the Bureau of Standards gas chemistry section, is to install additional automatic gas-analysis equipment which has been designed by the Bureau of Standards gas laboratories for use in the Government helium plants located in Petrolia, Tex.

The new equipment will record automatically the composition of the gas at twelve points in the plant, giving a written record every six minutes by equipment operating upon the principle of the differences in heat conductivity of the gases. At different points the relative amount of gas from two fields of the supply station, the relative percentages of methane and ethane, the relative percentages of methane and nitrogen, and relative percentages of nitrogen and helium, will be recorded.

This is the second and by far the larger instaliation which has been developed by this organization for the Government helium plants under the direction of E. R. Weaver, chief of the gas laboratories, Bureau of Standards.

[1] For more detailed information concerning the influence of the various chemical elements in high-speed steel, the reader is referred to the works of Messrs. Arnold, E. T. Edwards, Carpenter, C. A. Edwards, Read, etc., in the *Journal* of the Iron and Steel Institute.

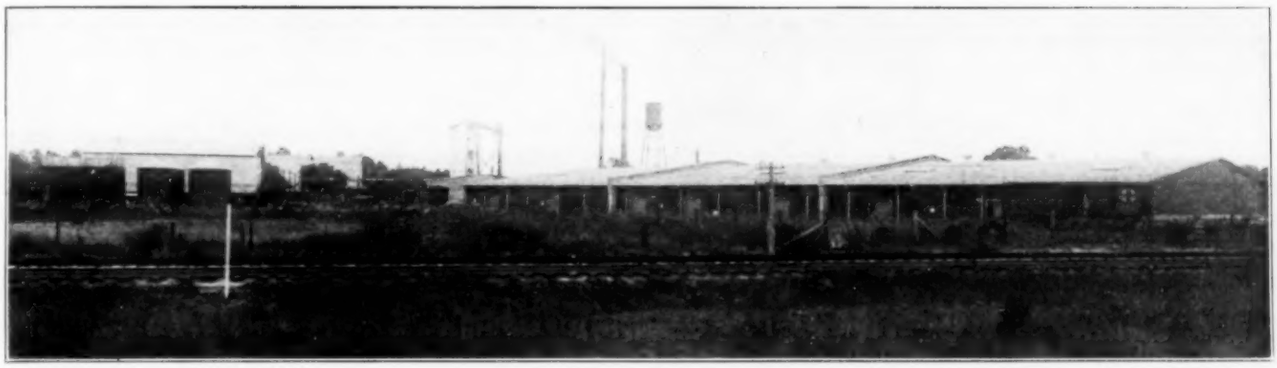

FIG. 1. GOVERNMENT CASTOR OIL PLANT, GAINESVILLE, FLA.

Operation of the Gainesville Castor Oil Plant

A Description With Many Details of the Expeller and Solvent Extraction Process of Obtaining a High Recovery of Oil From Castor Beans—Cleaning and Tempering Beans—Drying and Bleaching Oil—Cake Extraction and Operating Difficulties

BY J. H. SHRADER* AND A. C. GOETZ†

WHEN the War Department decided that castor oil was absolutely essential for the lubrication of a certain class of airplane motors (rotary, air-cooled motors, notably the Gnome engine), it was found that the Government would have to secure about 5,000,000 gal. of castor oil. Even the industrial demands were in excess of this supply, on account of the difficulty of importing the beans. Hence, to assure to the army an ample supply of oil, it was necessary to arrange for a corresponding supply of beans. Since the heretofore greatest producer and exporter of this commodity was India, and since also the British Government needed a large supply of oil, the American officials not only sought far and wide for beans, but also contracted extensively through the Southern states for home grown beans. To crush this crop, save hauling at a time of great railroad congestion, and at the same time leave the meal and hulls in the localities where they could be utilized readily, the Government decided to erect a mill in the castor bean belt. At Gainesville, Fla., a large turpentine extraction plant, temporarily shut down on account of conditions attendant on the war, was leased. With this as a nucleus, the oil-expressing mill, warehouses and tanks were soon added. This equipment was purchased outright and held as Government property. Thus the expressing mill and equipment was owned by the Government, but the extraction plant was leased under a contract to return it to its owners. The whole plant was operated by the Gillett Oil Co., which was under contract to crush the crop and produce oil of specified quality. The Government was to pay for the cost of operation and allow the company a fixed rate according to the tonnage of the crush.

The plant consisted of a large seed storehouse, an expeller and refining room, an extraction house, a pomace storage house, together with sheds, tanks and engine room. A panoramic view of the plant is presented in Fig. 1.

CRUSHING THE BEANS

The procedure in castor bean crushing may be briefly outlined as follows: After weighing and cleaning, the beans are conducted to the heaters. These raise the temperature of the beans to about 100 deg. F. and discharge them direct into the expellers. These machines are continuous in operation and press out the oil and meal in uninterrupted separate streams. The oil is conducted to tanks, weighed and refined. The meal is conveyed to the extraction house, where it is placed in large retorts and treated with benzol to extract out the residual oil. The two grades of oil thus produced, namely, the No. 1 oil by expelling, and the so-called No. 3 oil by extraction, are tanked and constitute the ordinary commercial grades.

The Gainesville plant was designed to crush 100 tons of beans per day of 24 hr., and it was fully capable of handling this tonnage if the crops had produced. Their failure resulted in a tonnage of only about one-fourth of the beans required for capacity running. As an experiment and demonstration the mill was run to capacity several times by accumulating ahead enough beans for the runs. The railroad sidings could accommodate sixty cars. There were the usual track scales and scale house.

After the cars of beans were weighed on the track scale, they were moved to the seed storage house, the flat building to the right in the picture. This was a frame building 150 x 300 ft., with cement floor holding 300,000 bushels, calculating 2 cu.ft. per bushel, with brick fire walls dividing it into three parts. The beans were unloaded from the cars and placed on trucks, ten bags to the truck. An occasional bag or truck load was weighed by another scale provided in the bean storage house; if this weight was found to check with the re-

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ported weight on the bag, the weight of the car was accepted as reported. If the weight of one bag or truck did not check with the reported weight, then the entire lot of bags was weighed in the bean storage house. The beans were then trucked in by hand, but a stacking machine was used for piling. This machine was made by the Brown Portable Conveyor Machinery Co., Chicago.

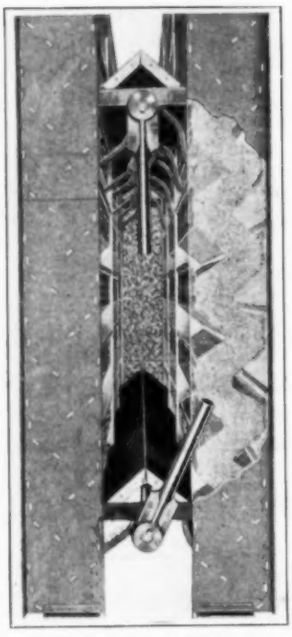


FIG. 2. HESS HEATER

Cleaning the Beans

Just below the surface of the floor in the middle of each half of the house were two belt conveyors each 300 ft. long covered with removable traps. Through wooden portable spouts, each holding the contents of a bag and large enough to set over a trap and deliver its charge clean, the beans were dumped onto the two conveyors and carried to an elevator, which raised them to a storage bin over the cleaner. The beans then dropped to a No. 4 Invincible Bean Cleaner, which had a capacity of handling 150 tons daily. This machine is made by the Invincible Grain Cleaning Co., Silver Creek, N. Y.

After passing through the cleaning machine, the beans were elevated to a storage bin, whence they passed to an Automatic Richardson Scale dumping 350 lb. at a charge. This scale is manufactured by the Richardson Scale Co., Passaic, N. J.

Tempering the Beans

From the scales the beans passed by a belt conveyor to a bucket elevator, which raised them to the heater. This heater was manufactured by the Hess Warming & Ventilating Co., Chicago, Ill., and had a capacity of approximately 150 tons per 24 hr. The Hess heater, Fig. 2, consisted of a galvanized iron hopper under which were columns of trays with pitched bottoms. The beans flowed downward by a zigzag course into another hopper, from which they discharged automatically through chutes to the expellers. The purpose of the heater was to raise the temperature of the beans in order to expedite the expression of the oil. The Hess heater was so arranged that in addition to the heating coils, there were open steam pipes. If the beans were found to be too dry, the moisture content and the temperature of the beans could be quickly increased by opening the live steam pipes, thus increasing the humidity of the heating room.

The heater was enclosed in a concrete room over the expeller room. (See Fig. 3.) The temperature of this room should be kept at 180 deg. F. In the construction of the chutes for the beans from the Hess heater, care was taken that the angle of slope was not less than 45 deg., to insure ready flow. In shutting down, the lower hopper of the Hess heater was left entirely empty so as to prevent the passage of cold beans from the heater when starting up again.

The expeller room, Fig. 4, was equipped with fifteen No. 1 Anderson expellers made by the V. D. Anderson Co., Cleveland, Ohio. The optimum temperature for the beans on entering the expellers was 120 deg. F. Good practice showed the temperature of the oil just as expelled to be about 80 deg. C. (176 deg. F.). The cake was about 120 deg. F. Actual tests of the temperature of the oil from the expeller taken just beneath the barrel as the oil was expelled were as follows:

	Temperature of Oil, December, 1919	Temperature of Oil, January 13, 1919
	79	74
	77	78
	79	84
	79½	87
	87	..
Average,	80	80½

The cake was about $\frac{7}{16}$ in. thick and ran 12 to 13 per cent oil and about 6 per cent moisture. The capacity of an expeller was 800 to 900 lb. of beans per hour with a 13 per cent cake.

A small jet of steam was allowed to play into the stream of beans in the chute just immediately before they entered the expellers.

Screens were placed under the barrels of the expellers to remove surplus foots or meal. In the earlier runs, the amount of meal per 24 hr. per expeller was probably not over four quarts, but this increased as the machines operated longer until it required auxiliary equipment to handle it. This was not provided; the result was a curtailment of capacity due to loss of oil in the meal. All such meal, when it became excessive, was sent to the extraction house, yielding its oil as No. 3 grade. From the expeller the oil was conducted by closed screw conveyors to a sump tank. The cake was delivered by screw conveyors to the extraction house, where it was loaded directly into the retort or stored on the charging floor. The operation of the extractors will be discussed later.

FIG. 3. EXPELLER HOUSE

The sump tank had a capacity of 750 gal. It was cleaned from two to three times a week, the foots from the cleaning being placed in the No. 3 mixing tank. From the sump tank the oil was pumped to the weighing tank, which had a capacity of 32,000 lb., or about 6-hr. run at full capacity. The oil was carefully screened before passing into the weighing tank to remove any particles of seed coats or hulls which might later give trouble in the bleaching of the oil. It was found that the presence of such particles materially darkened the oil in the heating prior to bleaching.

Vacuum Pans

From the weighing tank the oil was pumped to the vacuum pan, 8 ft. diameter x 15 ft. depth over all, with a 4-in. vacuum pipe, made by the F. J. Stokes Machine

Co., Philadelphia, Pa. This pan had a capacity of 30,000 lb. of oil, but it was usually operated with 26,000 to 28,000 lb. Six to eight hours were required to dry the oil in the vacuum pan at a temperature of 230 deg. F., using 28 in. of vacuum. One of the three mixing tanks or bleaching tanks was also fitted up as a vacuum tank and could be used as such when necessary.

In order to secure the best possible agitation and to secure a thorough dehydration, the oil was pumped out from the bottom and into the top of the tank and thus circulated in one complete cycle two or three times within the period that the oil was being dehydrated.

Bleaching

The oil in batches of about 18,000 lb. then passed from the vacuum pan to the mixing or bleaching tanks, of which there were three—two for No. 1 oil and one for No. 3 oil. If the mixing tanks were all in use, the oil could be passed to the storage tank. In the mixing tanks the oil was agitated and brought to a temperature of 210 deg. F., held there for a short time and then dropped to 190 deg. F., when 2 per cent Florida fullers earth and 0.85 per cent decolorizing carbon bought from Salomon Bros., New York City, were added. When the temperature of the tank was over 190 deg. F. it was always under a vacuum. The oil in the bleaching tanks was circulated when the fullers earth and carbon were added and during the whole period of bleaching.

After agitation the oil was passed through the usual type of plate and frame filter presses containing thirty-six 30 x 30 plates. Each plate was covered by a sheet of Bachman filter paper and one duck cloth, the oil passing first through the paper and then through the duck. The filter paper for the plates enabled the cloths on the first press to be used for three batches of oil, whereas when the paper was not used the cloths had to be changed for each batch.

After passing through the first press, the oil was run back to the mixing tank until it flowed clear, whereupon it was pumped through the second press, which was of the same description as the first press, but provided with one cloth and two papers. The pressure on the first press varied from 50 to 125 lb. per sq.in., the maximum pressure on the second press being about 40 lb. The finished oil passed from the second filter press to a small preliminary storage tank, thence to the large storage tank.

There were in all four filter presses. One filter press

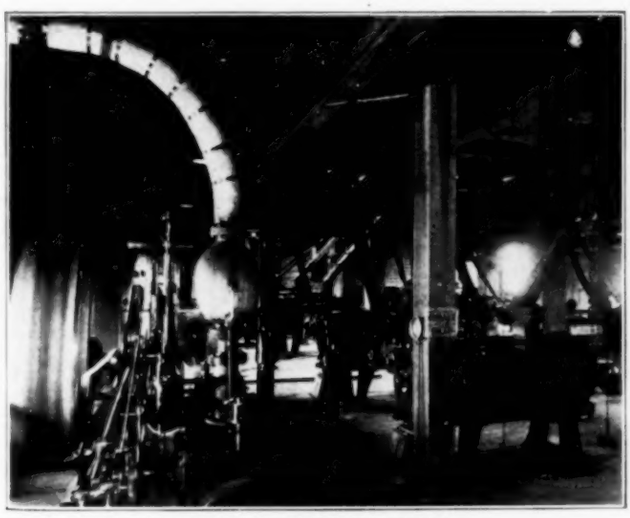


FIG. 4. EXPELLER ROOM

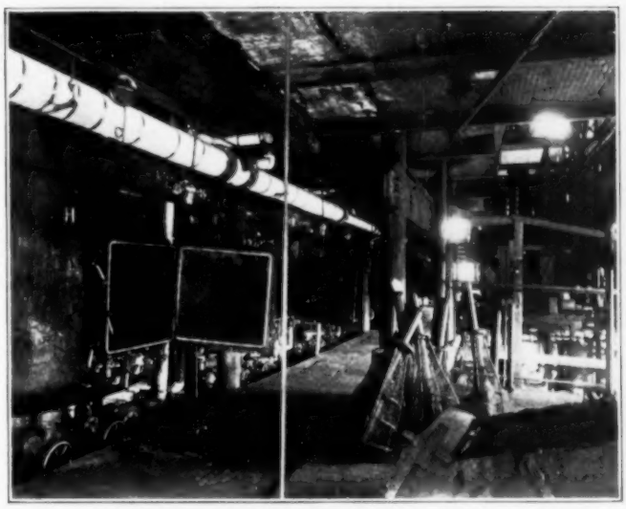


FIG. 5. RETORT BUILDING

was used for filtering No. 3 oil exclusively. Under ordinary conditions when the filter presses worked well, a 2,200-gal. batch of oil could be filtered in about 3 hr. Compressed air was blown through the filter presses after filtering to remove as much of the oil as possible. The filter cloths were cleaned by first soaking and washing in caustic soda water, then rinsing in hot water, wringing and drying. The residues from the cloths were sent to the extraction house to recover the last traces of oil.

In pumping the oil in the refinery, there were used two 2½-in. belt-driven rotary oil pumps, standard No. 6, each equipped with a 2½-in. suction and a 2½-in. discharge, manufactured by the Gould Manufacturing Co., Seneca Falls, N. Y. These pumps gave entire satisfaction.

The capacity for storing No. 1 oil consisted of one 250,000-gal. tank and three 30,000-gal. tanks. In addition there were two 5,200-gal. filling tanks and one 30,000-gal. storage tank for No. 3 oil.

Extraction Plant

Difficulties Experienced. The extraction plant was formerly used by the Florida Industrial Corporation for extracting pine tree stumps for turpentine, rosin, etc., and was erected by the Ernest Scott Co., Fall River, Mass. (Fig. 5.) The extraction apparatus worked very well for the extraction of the above products, but was unsatisfactory without remodelling for the extraction of the castor pomace. The principal changes in the plant were in piping and the addition of a system for agitating the charge and breaking up channelling.

There were eight extractors, each 9 ft. in diameter x 12 ft. tall, arranged in groups of four. It was estimated that the extractors would hold 3,000 lb. of pomace to the vertical foot. Considerable difficulty was experienced at first in operating the extraction plant, largely because stirrers or sweeps were readily broken from the shaft during the process of agitation. At first they were placed so as to clear the floor of the extractor; they were then raised to about 2 ft. above the floor and provided above and below with teeth 2 ft. long and 6 in. apart. This arrangement, however, did not work satisfactorily, for the sweeps still broke. Another difficulty experienced was in drying the castor pomace after extraction, due to it packing so tightly during extraction and steaming off of solvent that the moisture could not

be removed. Instead of loading 10 tons in one charge into the extractor, only 2½ to 5 tons could be loaded. If the pomace was not dried to within a moisture content of 12 to 13 per cent or, better, 10 per cent, it decomposed with a loss of ammonia, resulting in a consequent decrease in the value of the pomace.

At the top a manhole admitted the pomace during charging; on the side near the bottom, a large door permitted the removal of the charge. An agitator of the single-arm, sweep type rotated on the vertical axis of the retort. The floors were constructed with false bottoms supported on girders. These bottoms consisted of first a circular iron plate (in sections) about ½ in. thick and perforated with ½-in. holes. Over this was placed another plate about ⅛ in. thick with ½-in. holes. This second plate worked very well for chips, but did not work for castor pomace. There was substituted for this upper plate a covering made by burlap over ¼-in. mesh chicken wire. Over this burlap was spread a layer of castor bean hulls about 6 in. deep. Much time and effort were devoted to this problem before a satisfactory solution was found.

Overcoming Packing of the Charge

In order to effect the removal of the last trace of the solvent and in order to dry the pomace, it was necessary to pass live superheated steam through it. Considerable difficulty was experienced in pumping the solvent and driving off the last traces of moisture and solvent on account of the persistent packing of the charge. It was found necessary to change the practice of pumping the solvent in at the top and down through the pomace to the bottom by reversing it, pumping in at the bottom and forcing the solvent upward. The height of the solvent in the extractor was regulated by an adjustable arm in the extractor added by the Gillett Oil Co. It was found that pumping from the bottom to the top gave very good results and overcame the difficulty due to the formation of an impervious layer. However, packing of the charge was still troublesome. This manifested itself by difficulty in drying the pomace; even the aid of a vacuum did not solve the problem. After trying many methods, the following was finally adopted in January, 1919, and found to give satisfactory results:

Placed proportionately around the inside of the extractors and near the walls were nine upright 1-in. capped pipes perforated with ½-in. holes about every 8 to 10 in. The height of these pipes was regulated by the depth of the charge. After extracting the oil from the pomace, it was found that if steam was blown through it by means of these upright pipes, the pomace could be made dry enough not to decompose. This method was tried out in one extractor and found to give such excellent results that the remaining extractors were adapted to this method of drying. Under this arrangement the extractors could be worked to handle ten tons of material to be extracted per charge, extracting to about 1 per cent of remaining oil. From loading to loading about 20 hr. was required, but this time was often reduced to about 15 hr. Even at 20 hr. per extraction the extractors could handle the expeller cake from a 100-ton daily expeller run.

Operation of the Extractor

The castor pomace was charged in at the top of the extractor and all openings on the extractors tightly sealed. Solvent was then pumped through the mass a sufficient number of times to extract all the oil economically. The first and usually the second washings were pumped direct to the storage tank, which led to the purifiers (solvent stills). The third and fourth washings were used for the first and second washings on the next extractor in the same unit. Sometimes heat was used when the solvent was to be pumped through the extractor and sometimes not, depending upon conditions. After the solvent had been pumped off from the extractor, the heat was applied by a closed coil to distill off the solvent.

The last traces of solvent were driven off by means of live steam blown through the mass of pomace in the retort. During the "blowing off" with steam, a vacuum of about 10 in. was used. This vacuum assisted greatly in driving off the last traces of solvent vapor and moisture. These were pumped to the separating tank, which consisted of one large tank with a partition almost dividing the tank in two, the moisture and solvent entering one side of the tank. The water settled to the bottom and the solvent overflowed the partition to the other side. The vents from this tank and the vacuum pumps were sealed by a barrel of oil. This oil absorbed the last traces of solvent, later recovered in a third purifier.

Purification of No. 3 Oil

After reaching the storage tank (about 5 ft. in diameter and 20 ft. long), the solvent and oil were conducted by gravity to the purifiers, made by Ernest Scott, Fall River, Mass. In the purifiers most of the solvent was driven off by steam, leaving the No. 3 oil behind, while the condensed solvent was pumped to the separating tanks. The oil was then conducted to a tank, where it was treated with live steam to remove all traces of solvent and to clarify the oil. The exhaust from this tank was also conducted to the separators. The No. 3 oil was then pumped to the mixing tank in the refinery, where it was treated with fullers earth in the proportion of 250 lb. of fullers earth to 2,200 gal. of oil, merely for clarifying purposes. The oil was then passed through a filter press to the storage tank. The capacity for storing No. 3 oil was one tank of 33,000-gal. capacity.

Extraction Operation Reports

An idea of the time and procedure in operating the extractors can best be obtained by study of the accompanying retort reports, Tables I and II:

TABLE I. GILLETT OIL CO. RETORT REPORT
Retort No. 3. Charge No. 16. Date Feb. 13, 1919

	Start	Stop	Remarks
Filling	4:25	4:35	
Pumping in solvent	4:35	5:00	
Circulating (boil)	5:00	5:55	
To storage	5:55	6:15	
Pumping in solvent	6:15	6:25	
Circulating (boil)	6:25	6:45	
Advance to storage	6:45	6:55	
Pumping in solvent	6:55	7:25	
Circulating (boil)	7:25	7:45	
Advance to No. 4	7:45	8:30	
Pumping in solvent	8:30	8:45	
Circulating (boil)	8:45	9:45	
Advance to No. 4	9:45	10:20	25 min. lost in draining line.
Pumping in solvent	....	....	
Circulating	....	....	
Advance to:			
Steaming	10:45	1:45	
Steaming	....	....	
Steaming	....	....	
Vacuum	1:45	2:45	4 hr., 5 min. lost by orders to wait until next shift.
Unloading	7:50	9:15	

TABLE II. GILLETT OIL CO. RETORT REPORT

Retort No. 4. Charge No. 15. Date Feb. 12, 1919

	Start	Stop	Remarks
Filling	12:25	12:35	
Pumping in solvent	3:55	5:30	3 hr., 20 min. lost on account not ready to work.
Circulating (boil)	5:30	5:45	
To storage	5:45	8:15	
Pumping in solvent	8:15	8:30	
Circulating (boil)	8:30	9:00	
Advance to storage	9:00	9:50	
Pumping in solvent	9:50	10:00	
Circulating (boil)	10:00	10:30	
Advance to storage	10:30	11:30	
Pumping in solvent	....	....	
Circulating	....	....	
Advance to	....	....	
Pumping in solvent	....	....	
Circulating	....	....	
Advance to			
Steaming	11:30	2:00 a.m.	
Steaming	....	....	
Steaming	....	....	
Vacuum	2:00	3:00	
Unloading	3:40	4:30	

Pomace House

From the extractors the pomace was dumped directly onto a conveyor and sent to the pomace house, a peaked building about 100 x 50 ft. and 50 ft. high, divided into two parts. The pomace passed from the conveyor to a No. 8 Bauer Bros. grinding mill, and thence by an elevator to a conveyor traveling the length of the house just under the roof. From this it was dumped in any part of the house desired. Mechanical conveyors loaded the pomace directly into cars.

The power plant consisted of one 200-hp. water tube boiler operating at 150-lb. pressure, and two return tubular boilers of the Casey-Hedges make, Memphis, Tenn., 200 hp. operating at 150-lb. pressure, giving a total of 400 hp. Wood was used as fuel on account of the plentiful supply and the scarcity of coal, but the latter was later used. Superheated steam was used throughout the plant. In the expeller room there was a Hamilton Corliss engine, 250-hp. girder frame type. In the powerhouse furnishing the electric power was a 260-hp. condensing Ames Uniflow engine directly connected with a 180-kw. generator.

There were also two 7¾-in. barrel type well pumps made by the Keystone Drill Co., Beaver Falls, Pa. These pumps gave more than an ample supply of water for boiler and fire purposes from two wells on the premises. There were also two sets of fountain sprays, for cooling the extractor and condenser.

Laboratory

The mill was equipped with a chemical laboratory to control all factory operations. This consisted of examining all incoming beans and finished pomace for moisture and oil. Such tests as bleaching, oil in expeller meal, and other matters of routine character, were carried out from time to time. Determination of the acidity of the finished oil was always necessary, as this and color were the only specifications under the control of the manufacturing procedure.

Capacity and Yields

At a time that all the fifteen expellers were operating they crushed in 8 hr. 82,800 lb. of beans, yielding 40,260 lb. of oil (about 5,000 gal.) with its attendant moisture. Another test run was as follows: 41,400 lb. of beans produced 15,962 lb. of oil (38.05 per cent). From Nov. 8, 1918, the date the plant commenced operation, to Dec. 31, 1918, there was produced 257,456 lb. (32,182 gal.) of No. 1 oil. To produce this, 715,000 lb. or 15,540 bushels, of beans were crushed. This corresponds to 36 per cent of No. 1 oil, or 15.56 lb. of oil to a 46-lb. bushel. The production of No. 3 castor oil was 4,300 gal., with about 2,000 gal. still in process of manufacture.

Analytical Data

Table III gives the analyses of the oil produced at this plant.

TABLE III. ANALYSIS OF CASTOR OIL RECEIVED FROM THE GILLETT OIL CO.

G. A. Kirchmaier, Chemist, Toledo, Ohio

No. 3500-A.

	Specification Tests	No. I	II	4th Run III	Batch 6 IV	Batch 7	Batch 8 V
5	Specific gravity, 15 deg.	0.962	0.961	0.961	0.9612	0.9611	
4	Color	Yellowish	Same	Same	Same	Same	
6	Solubility	Soluble	Same	Same	Same	Same	
7	Acidity, acid number	1.7	2.91	2.1	2.4	2.3	
9	Iodine number	85.1%	80.8%	83.7%	85.4%	86.1%	
10	Saponification number	179	180	180	178	182	
12	Unsaponifiable number	0.3%	0.21%	0.28%	0.26%	0.3%	
13	Rosin	Negative	Same	Same	Same	Same	
14	Cottonseed oil	Negative	Same	Same	Same	Same	
16	Viscosity (Engler)	2019	2020	2020	2018	2019	
17	Flash point	526° F.	525° F.	525° F.	526° F.	527° F.	
18	Cold test (Zero F.)	O. K.	O. K.	O. K.	O. K.	O. K.	

All of the above samples comply with U. S. specification, the oil is good, a trifling yellowish cast or color, could be removed with bone black and clay to satisfy requirement in drug trade, but not necessary for mechanical use.

The beans crushed were almost entirely the first crop of those raised in this country from imported seed. The analyses extend over the whole period of operation from November, 1918, to June, 1919, inclusive.

BEANS	Per Cent	POMACE	Per Cent
Moisture	5.31	Moisture	13.04
Oil	45.15	Oil	2.40
Highest value	57.50	Lowest value	0.20
Lowest value	38.00	Highest	25.95

These values are not selected, but include all batches, notably those produced early in the operation before the extractors were made to perform satisfactorily. The average for the last few weeks of the operation was: Oil, 1.03 per cent; moisture, 10.13 per cent.

Oil No. 1		Oil No. 3	
Specific gravity	0.9620	Specific gravity	0.9614
Acidity, per cent	0.98	Acidity, per cent	4.80

A sample of hulls analyzed:

	Per Cent		Per Cent
Moisture	10.35	NH_3	1.27
Oil	1.88	K_2O	1.99

A sample of pomace analyzed:

	No. 1 Per Cent	No. 2 Per Cent
Moisture	15.05	11.28
NH_3	4.49	5.81
K_2O	0.89	0.99

Quality of Products

No. 1 oil: The No. 1 produced when operations first began had a higher color and higher acid (about 1.25 to 1.50 per cent) than the usual c.p. castor oil of commerce. The acidity of No. 1 oil later on ran about 1 per cent acid. The color of this oil was as light as most of the No. 1 oil produced by the regular trade, but was slightly muddy or dull or not quite so snappy in appearance as some No. 1 oil. The slightly dull appearance was not noticeable to the layman and could be noticed only when compared directly beside the very best No. 1 oil of the regular trade.

The production of No. 1 oil improved in quality steadily, and earlier poor batches were better as regards color and acidity than some No. 1 oil old process previously produced and now produced by the old established firms.

No. 3 oil: The No. 3 oil at first was very dark in

color, but improved very markedly until that later produced was equally as good as the regular No. 3 oil on the market.

Pomace: Due to the high moisture content of the pomace caused by the earlier poor operation of the extractors, the pomace produced at first heated and decomposed. With the later methods of operating the extractors, a low or normal moisture content was secured. The pomace also was uniform in fineness, which was a quality not possessed by some of the old-established brands.

General Statement

The Government castor oil mill was the first castor oil mill, expeller process, on a large scale ever erected. Some years ago castor oil was made by this method with success, but no large mills were ever erected using exclusively this process. Heretofore the old-type hydraulic process was used. Really the only difficulty experienced at the Government castor oil mill was in the operation of the extractors. These difficulties have been previously described. At the time of closing down, the plant was doing all and more than it was expected to do. It produced a castor oil which conformed to the specifications of the Air Service and further conformed to the U. S. Pharmacopœia castor oil. The production of the plant was earlier limited by the capacity of the extractors, but these were so improved that the mill met the original expectation, which was a capacity of 100 tons per day of 24 hr.

If the war had continued, the production of castor oil at this mill for airplane lubrication would not have been retarded. The capacity of the expellers could be pushed to 150 tons per day. Under stress of war times, no doubt, the extractors could have been put in satisfactory operation sooner. As it was, however, they were finally working successfully and producing a satisfactory pomace, extracting the pomace down to 1 per cent of oil, much better practice than obtained in some of the oldest and largest mills in this country.

Thus in about eight months the Government built and operated the largest castor oil mill in the world and produced high-grade oil from beans of local production, whereas the American castor bean crushing industry was built up on crushing beans mostly of East Indian variety. In the above short period this mill produced a grade of oil fully up to the specifications of the Air Service and ahead of expectations in a commercial sense. Objection has been made that the oil deposits a slight amount of foots on standing. Some of this oil does so react, but since ordinary commercially produced oil does likewise, it can hardly be charged with justice against the operation of the above plant. Another objection encountered was with respect to the excessive wear on the expellers. It was found, however, that they do not wear any more than with operating on peanuts. Excessive meal is discharged during long operating, but auxiliary equipment can handle this trouble. One of the best commentaries on a process is the attitude of the operators to it. In this case, they would unquestionably use expellers for crushing castor beans. With regard to the operation of the extractors, the staff made them applicable to extracting castor beans, one of the most difficult oil-seeds to handle due to the mushy, non-fibrous character of the kernel. Only the cessation of hostilities and partial failure of the home-grown bean crop prevented the mill from functioning fully up to its estimated capacity.

A Plea for the Scientific Study of Cellulose Chemistry

By Harold Hibbert

In A previous communication on "The Future of Industrial Organic Chemistry"[1], it was pointed out by the writer that the study of aliphatic compounds has been subordinated both here and in Europe to that of the aromatic, and this in spite of the fact that the actual cash value of the latter is an insignificant sum in comparison with that of the former. Attention was directed to the value of the United States cotton crop for 1918, which according to the report of the Department of Commerce amounted to the huge sum of $1,616,207,000.

Importance of Cellulose Industry

If we consider the total amount involved in the production and utilization of cellulose in the manufacture of such products as textiles, paper pulp, vulcanized fiber, artificial silk, cellulose nitrate and acetate, viscose (artificial silk) and celluloid, the total amount involved is probably greater than in any other single industry, with the possible exception of steel and coal.

In view of the fact that by far the greater portion of the world's supply of cotton is grown in America and that all of the industries mentioned above are now established here on a firm footing, it is difficult to understand why the scientific study of the chemistry of this so fundamentally important raw material should have been almost entirely neglected. The results of such neglect are apparent in every field where the application of cellulose plays an important role, for all of these industries have been built up essentially on empirical data rather than based on deep-seated knowledge of the nature of the constitution of the cellulose molecule.

Few American Contributions to Chemistry of Cellulose

During a discussion on cellulose at a recent meeting of the New York Section of the American Chemical Society[2] it was pointed out by the writer that the scientific study of cellulose chemistry has been neglected to such an extent that it is not only necessary for the American student to study abroad (since few facilities are available in any American university or college), but that he has also to depend on foreign literature for the fundamental and scientific facts covering this field.

It may possibly be of interest to record the fact that a review of the contents of the *Journal* of the American Chemical Society for the period 1893-1918 shows that during this interval of twenty-five years only three papers were published under the heading of Cellulose or Cellulose derivatives. Of these three papers one represents a contribution from the Sheffield Scientific School, Yale University, in 1907 on the "Estimation of Cellulose in Wood," by Dean and Tower. The second is entitled "Notes on Cellulose Esters," by R. G. Woodbridge, and was published in 1909 as a contribution from the Massachusetts Institute of Technology, while the third is a paper on "New Solvents for Cellulose," by H. G. Deming, published in 1911 from the University of Wisconsin. It is of interest in this connection that the second research was carried out with funds provided by Dr. Arthur D. Little for the purpose of carrying out

[1] Chem. & Met. Eng., vol. 21, pp. 335-341 (1919). This article was reproduced in *Chemiker Zeitung*, vol. 43, pp. 573-576 (1919), under the title "Die Ueberschaetzung der aromatischen und Unterschaetzung der aliphatischen organischen Chemie."

[2] Chemists' Club, New York, Nov. 7, 1919.

"scientific" (as distinct from "technical") research. This total contribution of three short papers to the advancement of the science of cellulose chemistry from a nation claiming a chemical society with a membership of about 13,000 chemists and controlling the world's supply of the raw material is not, it must be admitted, one which the American Chemical Society as a body, or the chemical industry, can view with any great degree of complacence. The surprising feature is that the industries themselves should not have contributed anything, and this in spite of the enormous wealth accumulated by them. This point is even more accentuated by the fact that during the same period several thousand contributions have been made by the chemists of other nations. This is plainly seen if we analyze the authorship of important articles referred to, for example, in the well-known text book on Cellulose by Schwalbe. An investigation of the references quoted in the footnotes shows that the total number of such amounts to about 2,500, of which 23, or less than 1 per cent, refer to American authors

Publication of Scientific Data Urged

On the occasion of the sectional meeting referred to above an earnest appeal was made by the writer to the large industrial companies to take an interest in the subject and, by publishing their scientific (as distinct from their technical) results, to assist the universities, colleges and chemical students generally in obtaining a more accurate and comprehensive knowledge of the subject, since it is only through publication that the progress of the science can be secured.

The industry has hitherto adopted an altogether too parochial attitude on such matters, but with the new spirit now in evidence a much better outlook is in prospect. Thus tribute must be paid to the scientific contributions on tungsten and other metals as well as to remarkable theoretical papers from the laboratories of the General Electric Co.; to the fine spirit shown by the du Pont company in financing and publishing scientific data on nitroglycerine, and to the contributions by The Barrett Co. and other large concerns, while the admirable series of library synopses planned by the Arthur D. Little Co. represent a praiseworthy public-spirited contribution to chemical progress.

In view of what has already been said, it is not in the least surprising that the information necessary for the development of new cellulose industries such as that of artificial silk, etc., should have had to be procured abroad.

The researches of Abel, Cross and Bevan, Green, Knecht, Fenton, Vieille, Grandmougin, Vignon, Chardonnet, Girard, Nastjukoff, Georgievics, Saposhnikow, Witt, Baeyer, Schwalbe, Ost, Will, and many others are well known to chemists, both scientific and industrial, and only make the absence of American contributions the more conspicuous. While tribute is gladly paid to the valuable compilations of Worden on cellulose derivatives, there is still lacking a comprehensive *scientific* textbook in English on the subject, comparable for instance to the well known textbook of Schwalbe.

The subject of cellulose chemistry, on account of the colloidal nature of cellulose, is closely related to, and interwoven with, that of colloid chemistry, and the enthusiasm and interest awakened in this latter subject through the efforts of Bancroft and others might well be utilized for the purpose of increasing our scientific knowledge in this field.

If we consider such subjects as the question of the best type of cellulose suitable for the manufacture of photographic paper, writing paper, celluloid, nitrocellulose, etc., we find each industry subjecting the raw material to a special treatment founded on data which are in the last analysis entirely empirical and which must remain so until the research chemist is able to provide some more definite data regarding the chemical nature of the cellulose molecule. How can the active interest of the chemist in the subject be best awakened and stimulated? The answer would seem to be first of all by the publication of the scientific data already in possession of the industries, and secondly by the endowment of several university professorships for the encouragement of scientific research in this field, together with provision for a considerable number of research scholarships.

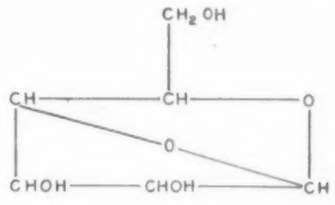
The country and the public generally are now both accustomed to the idea of special industries being concentrated in the hands of a limited number of companies, since it is only through the combined wealth associated with such organizations that sufficient funds are available to meet the large expense involved in carrying on more or less unproductive research for long periods of time. Granting this, they have at the same time the right to demand, in view of their benevolent attitude toward such trade combinations, that these latter shall repay such considerations by contributing their share to the progress of the science, progress which can be assisted in no better way, in the writer's opinion, than along the lines just indicated.

The time has long since passed when the country's knowledge of cellulose chemistry should be confined to the ranks of a few technical experts and it is to be hoped that the coming decennium will witness the publication in American journals of a vastly increased number of valuable scientific and technical communications on cellulose chemistry.

Constitution of the Cellulose Molecule

It must not be forgotten that the problem of the constitution of the cellulose molecule is one requiring the intimate co-operation of the botanist, the organic chemist and the physical chemist. Sooner or later America will presumably have its National Research Institute and the study of the chemistry of cellulose and wood products would seem to be one peculiarly adaptable to such an environment. In the meantime the universities, if liberally endowed and financed, can contribute much of value, as the forthcoming publication of the brilliant researches carried out recently at Yale by Prof. T. B. Johnson and his pupils on the constitution of silk will clearly demonstrate.

In connection with a forthcoming paper dealing with a new formula for cellulose proposed by the writer, namely,



it is hoped that opportunity may be found for a discussion of certain promising lines of scientific research in this field.

Yale University,
New Haven, Conn.

Electrochemical Industries in Sweden

By J. W. Beckman

A VERY extensive investigation on the utilization of water power for electrochemical purposes in Sweden has recently been published by Prof. Wilh. Palmaer, professor of chemistry at the Royal Technical University of Stockholm, and the growth of the industry, as indicated by him in this publication, is of such a kind that it should stimulate countries situated in a similar way to further efforts.

Sweden is a sparsely-settled territory which is about as long as the Pacific coast between the Mexican line and the Canadian line. Its total width is not over 300 miles, which naturally affects the transportation question very materially.

It has been customary all over the world to look to Sweden and Norway as pioneers in the electrochemical developments and this is primarily due to the fact that the people of Sweden have at an early date been impressed, through the means of the daily papers, of what hidden wealth was stored away in the flowing rivers of that country.

Prof. Palmaer's pamphlet covers the field completely up to 1918. When the Swedish production figures are compared with similar figures of the United States, they are pygmies, but in spite of that, Swedish electrochemical products are found all over the world.

Electrochemical Sodium and Potassium Salts Industries

The total power used in the manufacture of caustic soda and bleach products in Sweden up to 1918 was 2,140 kw., which was divided among four factories. The reason for the comparatively small production of these products is due to the fact that salt, essential as raw material in this industry, has to be imported from Germany or the southern countries of Europe. The cost of this material is therefore considerable and has held back the industry, though there is a large demand both for caustic and bleach. In all the paper mills bleach is needed badly, and large quantities of this material have been imported from as distant countries as the United States.

Potassium chlorate and perchlorate have been produced in considerable quantities and 750 kw. is consumed by this industry alone. The chlorate manufacture is one of the oldest electrochemical industries in Sweden and has an enviable position on this account.

Other Electrochemical Industries

The calcium carbide manufacture has been carried out with a total power consumption of 24,000 kw., with an increase during the war of about 25 per cent.

The fixation of atmospheric nitrogen has gone forward considerably, and the latest information indicated that 16,375 tons of cyanide was produced and 12,000 kw. was consumed in the synthetic manufacture of nitric acid.

The shortage of sulphuric acid in Sweden during the war and the demand for increased food-product yields stimulated the possibility of developing electrochemical phosphate processes for the production of a soluble phosphate suitable for fertilizing purposes. Prof. Palmaer has developed such a process, which has shown itself efficacious under special conditions.

At the present time there is being used 2,000 kw. for the manufacture of potash salt and potassium cyanide in electric furnaces. The process has proved itself successful, and should open the field for the synthetic manufacture of potassium cyanide in parts of the United States where potash silicates and cheap electric power are available.

There is being utilized at the present time 700 kw. in the manufacture of carborundum, and the manufacture of alundum has been under serious consideration. For the manufacture of artificial graphite 1,650 kw. is being utilized.

About 1,000 kw. is being utilized, in two different plants, in the manufacture of phosphorus. In addition to the industries mentioned above, a number of small plants taking close to 1,000 kw. are operating, producing hydrogen, oxygen, hydrogen peroxide and other products, which find a ready market in the country.

Electric Iron, Steel and Ferro-Alloys

The Swedish pig-iron industry is gradually being changed over to an electric pig-iron industry, and the impulses have been strong along these lines during the war years. The total power consumption for the manufacture of pig iron in electric furnaces up to 1918 was about 70,000 kw., an increase of three and a half times that in 1915.

Along with the electric smelting of pig iron the electric steel furnaces have grown and there are at present installed forty-two electric steel furnaces consuming 7,975 kw.

The ferro-alloys, such as ferromanganese, ferrochrome, ferrosilicon, silico-aluminum, manganese-silico-aluminum and manganese-copper, have grown parallel with the steel industries, and the total consumption for these industries amounts to approximately 45,000 kw.

Electrolytic Copper Refining

Other metallurgical processes have been contemplated, but the most interesting is the electrolytic refining of copper, a matter which is of great importance to Sweden, since the country's electrical industries are highly developed and the need for refined copper for these is very essential. Small amounts of copper are produced in the country, and these will be refined there. The war, of course, has indicated the danger of complete dependence on outside sources for refined copper.

Summary

The following table shows the growth of electrochemical industries in Sweden during the years 1904-1917:

Year	No. of Electrochemical Plants	No. of Kw. Consumed	Value of Products in Swedish Crowns*
1904	8	9,000	4,500,000
1908	10	13,500	7,500,000
1911	14	25,000	11,000,000
1913	22	60,000	20,000,000
1915	36	78,000	31,000,000
1917	75	126,000	55,000,000

* $1 = 3.75 crowns at normal exchange.

San Francisco, Cal.

Photo-Sensitizing Dyes in Demand

Extensive commercial use is being made of the sensitizing dyes produced by the Bureau of Chemistry as a part of its war work. The recent successful development of color photography is resulting in a brisk demand for isocyanines, pinaverdol, pinacyanines, krytocyanines, and other sensitizing dyes. They were developed originally for aircraft photography.

Supply of Inorganic Nitrogen in the United States

The Inadequate Domestic Supply of Nitrogen in the United States Is Supplemented by Importations From Chile—Summary of Figures on Consumption and Supply Showing Deficiency Even if Government Plants Are Operated

By Major D. P. GAILLARD
Nitrate Division, Ordnance Department, U. S. A.

A PREVIOUS paper on the consumption of inorganic nitrogen in the United States outlined the conditions during the last twenty years and considered the factors that would probably affect our consumption of nitrogen in the future.* It is important to investigate the source of supply of nitrogen from which this demand can be met. The United States has been very largely dependent upon importation for its supply of nitrogen, as only a small part of the total nitrogen consumed has been produced here. This domestic production has come from the recovery of nitrogen contained in all bituminous coal in connection with coking for the manufacture of coal gas and byproduct coke. The principal source of imported nitrogen has been the nitrate fields of Chile. There have also been imports, comparatively small in amount, from Europe of byproduct nitrogen and from Canada of nitrogen fixed from the atmosphere. The supply of nitrogen, therefore, comes from imports and domestic production.

Nitrogen Recovered From Coal

Byproduct Coke Production

Byproduct coke ovens were first introduced in this country about 1893, but by 1902 the total coke production from this source was only 5 per cent of the total. There was a more or less constant growth to 1912, in which year about 25 per cent of the total coke was produced in byproduct ovens. The consequence of this very rapid increase was a tendency toward an oversupply of byproducts, and consequently the building of additional byproduct ovens was checked somewhat until stimulated by the war. Since 1914 the increase has been abnormal, owing to the demand for the byproducts in the manufacture of munitions. In 1917 and 1918, in order to secure an adequate supply of toluol, the basis of TNT, the Ordnance Department stimulated by special contracts the construction of many additional byproduct ovens. The last of the ovens so constructed will not be completed until about the middle of 1920. As the result of this increase, in 1918 about 46 per cent of the total coke was produced in byproduct ovens. In 1919 the demand for coke decreased very considerably, and while the production of byproduct coke fell off 4 per cent from the 1918 figures, the production of beehive coke fell off 44 per cent from figures for the previous year, as the consequence of which the proportion of byproduct coke produced in 1919 was 56 per cent.

The byproduct ovens now in existence, together with those contracted for during the war and now under construction and nearly completed, it is estimated can furnish a maximum coke production of 36,500,000 tons a year, or 64 per cent of the record high 1918 consumption; or 82 per cent of the 1919 consumption of coke, which although considerably lower than that in 1918, has previously been exceeded in only three years and equaled in one other year.

Beehive Coke Production

These figures without further study might confirm the popularly held idea that the beehive ovens in this country are being replaced by byproduct coke ovens, but this has not been the case. A study of the coke production statistics compiled by the U. S. Geological Survey shows that in the last fifteen years there has been no general decrease in the production of beehive coke. The average annual production of beehive coke during this 15-yr. period is approximately 29,900,000 tons. For the first five years of this period this production averaged 30,100,000 tons, for the next five years 30,400,000 tons, and for the next five years 29,300,000 tons; or, in other words, there has been a falling off in the last 5-yr. period over the first 5-yr. period of only 3 per cent. It is evident, then, that the byproduct coke ovens in the last fifteen years have been built to take care of the increase in the demands of the country for coke, but that, considering the country as a whole, there has been no substitution whatever as yet of byproduct ovens for beehive ovens.

Future Pig-Iron Production

To forecast intelligently the future demand for coke it is necessary, as has been stated before, to consider the probable growth in the pig-iron industry, a fundamental industry of the country and one reflecting so accurately the general business conditions that it is often used as a "barometer of industry." A study of the statistics of pig-iron production as reported by the U. S. Geological Survey shows a practically constant growth in the last twenty years, the annual increase averaging about 1¼ million gross tons per year. The industry has grown somewhat irregularly, periods of reduced production following every few years periods of record production; but the growth given above represents the average growth during this period. The production fell in 1914 because of the poor business conditions prevailing that year owing to the outbreak of the war. It recovered to approximately normal the next year, rose to a record high figure of 39,434,797 tons in 1916, declined very slightly in 1917 and again in 1918, being 38,230,440 tons in the latter year. With the cessation of war demands and the absorption of war stocks of iron, together with the hesitation of business while waiting for lower prices, as well as with the interruptions caused by steel and coal strikes, the production fell in 1919 to approximately 30,500,000 tons. If the normal growth of 1¼ million tons per year had continued to 1920, it is estimated the consumption last year would have been in the neighborhood of 36,000,000

*See Chem. & Met. Eng., vol. 22, No. 17, p. 783.

tons instead of 30,500,000 tons, as was actually the case.

During the war steel was to a very considerable extent cut off from non-essential industries, and a great amount of construction work was postponed. It is reasonable to assume that in the next few years the major part of these accumulated unfilled requirements must be met. Further, the growth in certain industries, such as the automobile and farm tractor industries, will require releatively increasing amounts of steel, and the substitution of steel for wood in bridges, buildings, and for various other uses will continue. Further, there is a possibility of some increase over our pre-war exports. On the other hand, it is unlikely that railroad requirements for steel—a very considerable part of the total requirements in past years—will be so great as previously. Furthermore, the production of pig iron in this country has doubled in the last fifteen years, increasing much faster than the population. In other words, the per capita consumption of steel and steel products has very materially increased in this period. It is evident that this increase cannot go on indefinitely, but opinions differ as to just how near the country is to the point of saturation.

In view of this it is believed that the most accurate estimate that can be made at this time is to assume that the production of pig iron in this country during the next few years will continue to increase at the average pre-war rate of 1½ million tons per year. Under this assumption pig-iron production in 1924 would be in the neighborhood of 43,000,000 tons, which amount, it is interesting to note, is somewhat less than the present total pig-iron capacity of the country as recently estimated by one of the trade journals. Under this same assumption the production in 1930 would be 50,500,000 tons.

Future Byproduct Coke Production

The coke required to produce 43,000,000 tons of pig iron, together with the amount of coke used for other purposes, would be, based on past experience, approximately 63,000,000 net tons. The byproduct ovens now built and building can supply approximately 36,500,000 tons, or approximately 58 per cent of this—a greater proportion of byproduct coke than there has ever been in the past—leaving, if no new byproduct ovens are constructed, a total of 26,500,000 tons to be furnished by beehive ovens. It is pertinent to note that this is only 89 per cent of the average beehive production for the past fifteen years, and that the beehive production during these fifteen years has fallen below this figure in only three years.

It is entirely possible that sooner or later byproduct ovens will supply from two-thirds to three-quarters of the total coke production, but it is very unlikely that they will displace beehive ovens to any greater extent than this. The iron industry has always been a business of ups and downs, and consquently the coke requirements have fluctuated from year to year. A study of the statistics shows in the last fifteen years four cases in which the production of coke has fallen off very considerably from the previous year, the percentage of decrease ranging from 36 per cent to 15 per cent of the production of the previous year and averaging for these four years 25 per cent. A byproduct oven once built must continue in operation if possible, not only because it must carry much heavier fixed charges on capital invested than the cheaper beehive oven, but if shut down it must be partly reconstructed at considerable cost before placed in operation again. On the other hand, the simple beehive oven can be put into operation after an extensive period of idleness at comparatively small cost. Business considerations would therefore indicate that the maximum production to be expected from byproduct ovens would be that production necessary to supply the minimum requirements, the difference between the minimum requirements and the maximum requirements—that is, the non-continuous requirements—being taken care of by the cheaper and simpler beehive ovens. A study of the statistics of coke production from these two sources for the past few years shows very clearly how much less capable the byproduct production is of fluctuating with the variable demand. For instance, in 1908 the production of beehive coke fell off 38 per cent from the previous year's figure, while the production of byproduct coke decreased 22 per cent. In 1911 the production of beehive coke fell off 21 per cent, while the production of byproduct coke increased slightly. In 1914 the production of beehive coke fell off 33 per cent and byproduct only 12 per cent. In 1919 the beehive production fell off 44 per cent and the byproduct only 4 per cent.

Increase in Byproduct Ovens Improbable

It is very unlikely, however, that in the next five years there will be any considerable number of new byproduct ovens constructed. Not only is the cost of construction more than double the pre-war cost, but the production of byproducts from the coke ovens now built and building will be approximately three times that of the highest pre-war year. Under these conditions, with the extensive world-wide demand for capital, it is difficult to see how any considerable amount of money will be invested in the byproduct coke oven industry, abnormally stimulated during the war, in order to further increase, in a period of high costs, an already plentiful supply of most of the byproducts.

It is possible, however, there will be certain individual byproduct coke ovens constructed where local conditions may be peculiarly advantageous; but it is believed that an allowance for the year 1924 of a million and a half tons of coke from byproduct ovens other than those now built and building is a very liberal one.

We therefore have for 1924 a maximum possible production of 36,500,000 tons of coke from coke ovens now built and building, and an additional allowance of a million and a half tons of coke from ovens which may come into production during this period, making an estimated total byproduct coke production in 1924 of 38,000,000 tons, or 60 per cent of the total coke production. This would require the coking of approximately 53,500,000 tons of coal.

In 1930 to manufacture the estimated production of 50,500,000 tons of pig iron and to meet the other requirements there will be required approximately 73,500,000 tons of coke. It is estimated that byproduct ovens will supply approximately 50,000,000 tons, or 68 per cent of this, leaving 23,500,000 tons to be furnished by beehive ovens. These figures compare with 38,000,000 tons and 25,000,000 tons estimated from these two sources for 1924. In other words, it is assumed that not only will all the increase in coke requirements be furnished from byproduct ovens, but also that byproduct ovens will replace the beehive ovens operating in 1924 to the extent of 1,500,000 tons of coke.

The production of 50,000,000 tons of coke in beehive

ovens would require the coking of approximately 70,000,000 tons of coal.

Yield of Ammonia

Statistics collected by the U. S. Geological Survey prior to the war indicated for the byproduct coke ovens all over the country an average yield of 5 lb. of ammonia per ton of coal coked. During the war, owing to the use of inferior coals and the lower efficiencies during forced production, this yield decreased to slightly less that 4½ lb. It is believed, however, that pre-war conditions can be equaled again and therefore in these estimates an average recovery of 5 lb. of ammonia per ton of coal coked is assumed. It is believed that this figure is liberal, and while in certain cases the recovery may run as high as 6½ lb., in other cases it runs very materially less than 5 lb.

Total Ammonia From Byproduct Ovens

On the basis of 5 lb. of ammonia recovered per ton of coal, we would have an ammonia recovery for 1924 from the coking of 53,500,000 tons of coal in byproduct ovens, of 133,750 tons of ammonia, equivalent to 535,000 tons of ammonium sulphate, and in 1930 from the coking of 70,000,000 tons of coal, 175,000 tons of ammonia, equivalent to 700,000 tons of ammonium sulphate.

Ammonia Recovered in Manufacture of Coal Gas

In the manufacture of coal gas coal is coked in retorts differing somewhat from byproduct coke ovens, but methods of recovery are very much the same. Exact figures for the several past years in the production of ammonia from this source are not obtainable, but as only a relatively small proportion of the total ammonia recovered comes from gas works and this proportion is constantly growing less, a reasonable approximation will be sufficient for our purposes.

In 1915 the U. S. Geological Survey reported a total production from gas works of 12,980 tons of ammonia, and in 1917 of 11,440 tons. These are the only two recent years on which exact statistics are available, but estimates of production during the last eight years show an annual production varying from a minimum of somewhat over 10,000 tons to a maximum of 13,000 tons. The high year was 1915, since when the production has apparently decreased slightly. It is believed that an allowance for 1924 of 15,000 tons of ammonia and in 1930 of 18,750 tons of ammonia from gas works will be ample in view of the experience in the last few years. Further it is believed that the extremely small amount of ammonia from bone carbonizing works can be included in these figures without error.

Total Ammonia Recovered From Coal

We thus have for 1924 as the maximum amount of ammonia that can reasonably be expected to be recovered from coal, 133,750 tons from byproduct coke ovens, and 15,000 tons from coal gas and bone carbonizing works, or a total of 148,750 tons, equivalent to 595,000 tons of sulphate of ammonia, or 122,500 tons of nitrogen. In 1930 we would have 175,000 tons of ammonia from byproduct coke ovens, and 18,750 tons of ammonia from gas works, or a total of 193,750 tons of ammonia, equivalent to 775,000 tons of sulphate of ammonia, or 159,500 tons of nitrogen.

The Fixation of Atmospheric Nitrogen

Commercial Plants

In the past there has been almost no quantity fixation of atmospheric nitrogen within the limits of the United States. For a few years a small arc process plant operated in North Carolina and more recently another small arc process plant has been operating in the state of Washington. Some other experimental and development installations operated on a very small scale, but the aggregate supply from all these sources has been a negligible factor in the country's total supply of nitrogen.

Government Plants

During the war, U. S. Nitrate Plant No. 1, at Sheffield, Ala., using the General Chemical Co.'s modification of the Haber process, and U. S. Nitrate Plant No. 2, at Muscle Shoals, Ala., using the cyanamide process, were practically completed.

Experimental operation had started at Plant No. 1, but the process is not yet developed and considerable further study of the fundamentals of the process and modification of the equipment are necessary before regular production can be secured from this plant.

Plant No. 2 was tested and showed conclusively that it could produce fixed nitrogen at its rated capacity—approximately 45,000 tons per year—at reasonable cost. Altogether No. 2 plant produced about 600 tons of nitrogen in 1918 and about 700 tons of nitrogen in 1919. The production from No. 1 plant was negligible.

Future Production From Government Plants

If Congress authorizes the operation of the two plants for the production of nitrogenous materials to be used in the manufacture of fertilizer as recommended by the War Department, it is estimated that the production from this source will be approximately 45,000 tons of nitrogen in 1924, gradually increasing to 55,000 tons of nitrogen in 1930.

Future Production From Privately Owned Plants

Within the last few months the General Chemical Co. and the Semet-Solvay Co. have joined forces for the further development of the Haber process in this country. It is most unlikely that there will be any considerable tonnage production from this source by 1924, as it is doubtful if the process will be developed on a manufacturing basis much before that time. If this process is worked out, which is still much of a question, it will gradually enter as a production factor and in order to be liberal it is assumed that by 1930 about 25,000 tons of nitrogen may be secured from this source. To secure this production will necessitate the investment of not far from $20,000,000, and it is not believed that this industry will develop any faster than this.

Nitrogen From Imports

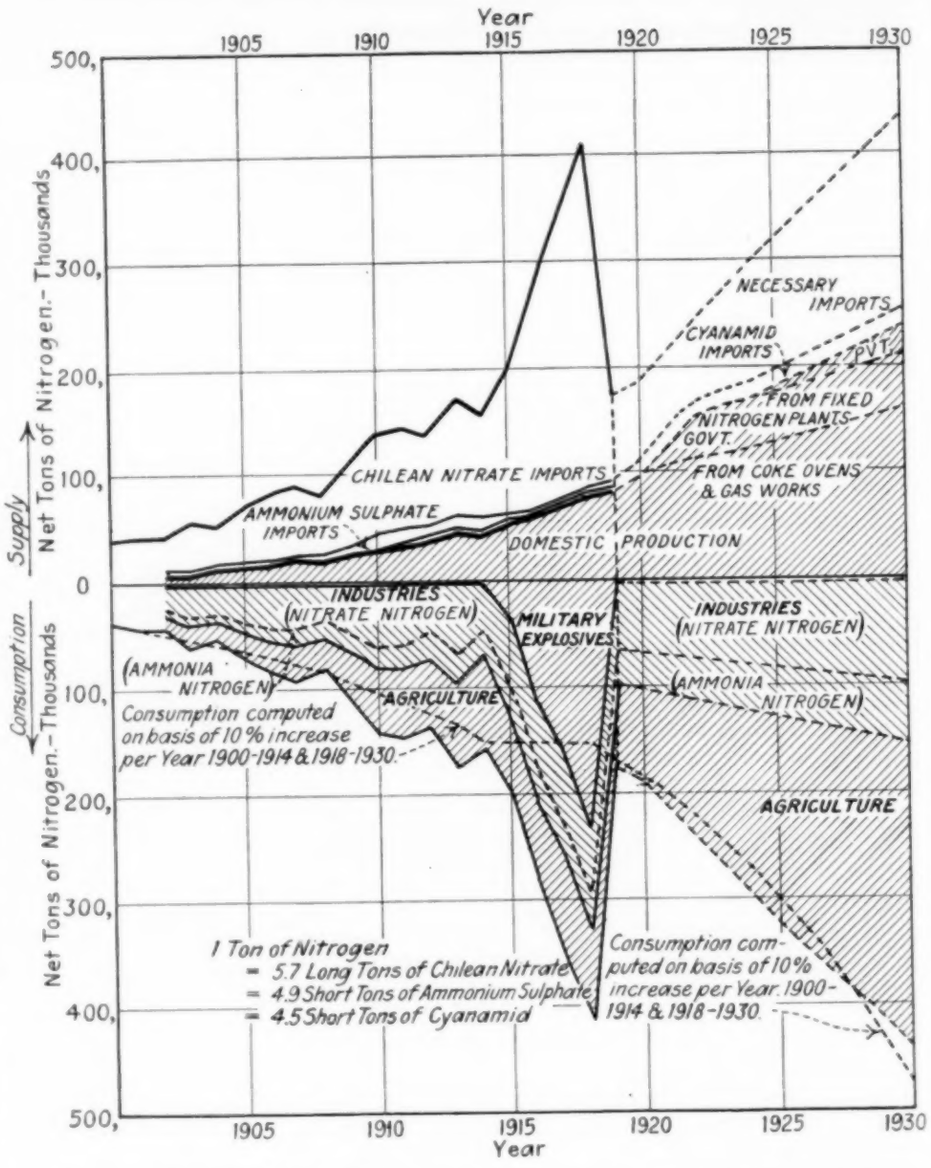
Past Imports

In the past twenty years more than three-quarters of the nitrogen consumed in this country has been imported, principally from Chile in the form of nitrate of soda, usually known as Chilean nitrate.

For a few years before the World War considerable amounts of sulphate of ammonia were imported, for the most part from England, furnishing at a maximum somewhat less than one-fifth of the total nitrogen im-

ported; but during the war England needed this nitrogen at home and imports from this source fell to almost nothing. The plant of the American Cyanamid Co. at Niagara Falls, Canada, for the fixation of atmospheric nitrogen entered into production in 1910 and imports of cyanamide from this plant have steadily increased since that date, but they furnished only a very small fraction of the total nitrogen imported. The main reliance of this country, however, in the past has been the importation of Chilean nitrate and the abnormal war demands were met almost entirely by expansion of this source of supply.

A study of the nitrogen situation indicates that the requirements of the country will in the future as in the past first absorb the domestic production. This will be the case as domestic nitrogen can always undersell any imported nitrogen. It is evident that this is true with the nitrogen from the byproduct coke ovens and gas works, where the cost of production, as is the case with any byproduct, is largely a matter of bookkeeping. This is also true in the case of the Government nitrate plants, which can fix and sell nitrogen at an operating expense less than any probable selling price of imported nitrogen in the next ten or twenty years. The nitrogen which it has been estimated will be produced in the future from privately owned fixed-nitrogen plants will certainly not materialize unless private capital is convinced that nitrogen from this source can undersell, if necessary, any imported nitrogen. In other words, under the conditions that will prevail in the future, when the consumption will be considerably greater than the domestic supply, the price will be controlled by the cost of the imported nitrogen necessary to supply the deficiency in the domestic production, and the imports will therefore just be sufficient to meet whatever deficiency there may be.



ACTUAL AND ESTIMATED SUPPLY AND CONSUMPTION OF NITROGEN IN THE U. S., 1900 TO 1930

Whether most of this imported nitrogen will be in the form of Chilean nitrate or whether some nitrogen may be obtained either from the European byproduct coke ovens or from European fixation plants is immaterial. It is believed, however, that most of it, over and above the relatively small amount contained in the cyanamide imported from Canada, will be furnished by Chilean nitrate, as has been the case in the past.

The imports of nitrogen, other than those of Canadian cyanamide, which it is estimated will furnish 15,000 tons of nitrogen, necessary to supply the estimated deficiency of domestic production in 1924 amount to 112,000 tons of nitrogen, equivalent to approximately 640,000 long tons of Chilean nitrate, and in 1930 to 183,500 tons of nitrogen, or slightly more than 1,000,000 long tons of Chilean nitrate.

Summary

The preceding consideration of the probable consumption in 1924 and 1930 of inorganic nitrogen for agricultural, industrial and military purposes, and the supply to be expected in these same two years from the coking of coal and the fixation of nitrogen within this country and the importation of sufficient nitrogen to meet the deficiency in domestic production, may be summarized as shown in the table.

In order that this forecast of future conditions may be readily compared with the actual conditions prevailing in the past, and in order that the trend of increase may be better studied, the accompanying chart has been prepared.

This chart shows the actual supply and consumption

of inorganic nitrogen for each year since 1900 and the estimated supply and consumption for each year to 1930.

It will be noted by a comparison of the bottom line on the chart showing total consumption with the dotted curve immediately above it that the total use of nitrogen in this country increased at a rate somewhat greater than 10 per cent each year from 1900 to 1914. The tremendous demand for nitrogen for military explosives during the World War materially checked this growth in the peace-time uses of nitrogen from 1914 to 1919. It will be noted, however, that the future consumption of nitrogen is estimated to continue at practically this same rate of growth, at least for the next ten years, and it is believed that the preceding discussion shows that this assumption is conservative.

SUMMARY OF ESTIMATED SUPPLY AND CONSUMPTION OF INORGANIC NITROGEN

Estimated Peace Time Consumption in	1924 Tons of Nitrogen	1930 Tons of Nitrogen
Agriculture	172,000	285,000
Industries	120,000	150,000
Military explosives, assumed	2,500	3,000
Total consumption	294,500	438,000
Estimated Domestic Supply from		
Coking of coal	122,500	159,500
Privately owned fixed nitrogen plants		25,000
Total domestic supply	122,500	184,500
Deficiency in domestic supply if Government plants do not operate	172,000	253,500
Estimated Supply From Government fixed nitrogen plants	45,000	55,000
Deficiency in domestic supply if Government plants operate	127,000	198,500
Estimated Imports Necessary		
Canadian cyanamide	15,000	15,000
Chilean or European nitrates, if Government plants do not operate	157,000	238,500
If Government plants operated	112,000	183,500
Proportion of Total Consumption Furnished by Domestic Supply	Per Cent	Per Cent
If Government plants not operated	41.6	42.2
If Government plants operated	56.9	54.7

NOTE—Nitrogen exported from the United States is not included in the above, as amount of future exports is uncertain, and if included only makes the deficiency of domestic supply more marked.

It will also be noted on this chart how the war demand, considerably greater than the entire consumption in this country of inorganic nitrogen for all purposes in any year prior to the war, necessitated importing from Chile in 1918 almost three times as much nitrogen as had ever been imported before, and it shows graphically how greatly dependent this country was during the war on this importation.

The chart shows further how the expansion of nitrogen supply from coke ovens and gas works, even though abnormally stimulated by the war demand, will not furnish in the future half of the nitrogen used in this country, and unless this source of supply is supplemented as soon as possible by the operation of the Government fixed-nitrogen plants, and further supplemented by such development of the private fixed-nitrogen industry that there may be, this country will be even more dependent on imported nitrogen ten years from now than it is at present, and not only will the country be less well prepared from a military point of view but the American consumers, which include directly a very large proportion of the farmers of this country as well as many of the most fundamental chemical industries, and indirectly the greater part of the population, will find it harder than ever to get an adequate supply of nitrogen at a cost within reason.

Influence of Slag and Nitrogen on the Corrosion of Iron

AT THE Boston meeting of the American Electrochemical Society, April 16, 1920, L. T. Richardson presented a paper on "The Influence of Enclosed Slag on the Corrosion of Wrought Iron," in which he noted the controversy between makers of pure steel and genuine wrought iron as to the relative merits of the two materials for resisting corrosion. Referring to Hadfield's, Rosenbain's, and Braune's work on ancient irons, he comes to the conclusion that "those ancient iron objects which have shown such a remarkable resistance to corrosion are made of puddled iron, and it is therefore only natural to expect that iron manufacturers of today in their search for a corrosion-resisting material should attribute the rust-resisting qualities of these old irons to just those properties that characterize wrought iron itself. These distinguishing properties are two in number—a chemical one that the iron is quite pure, and a physical one that the iron has long layers or threads of slag or cinder scattered throughout its mass. Some even go so far as to say that each fiber is coated with an almost infinitesimal film of slag. It almost follows that because of these two different characteristics, the resistance of wrought iron to corrosion should be ascribed to two different causes by two classes of observers—one claiming that the resistance of wrought iron to corrosion is due mainly to its chemical purity; the other contending that it is due to its physical structure.

"The very structure of wrought iron offers a means of testing, to a certain extent, these two theories.

"It is easily seen that in one direction, namely, perpendicular to the slag layers, the metal is not contin-

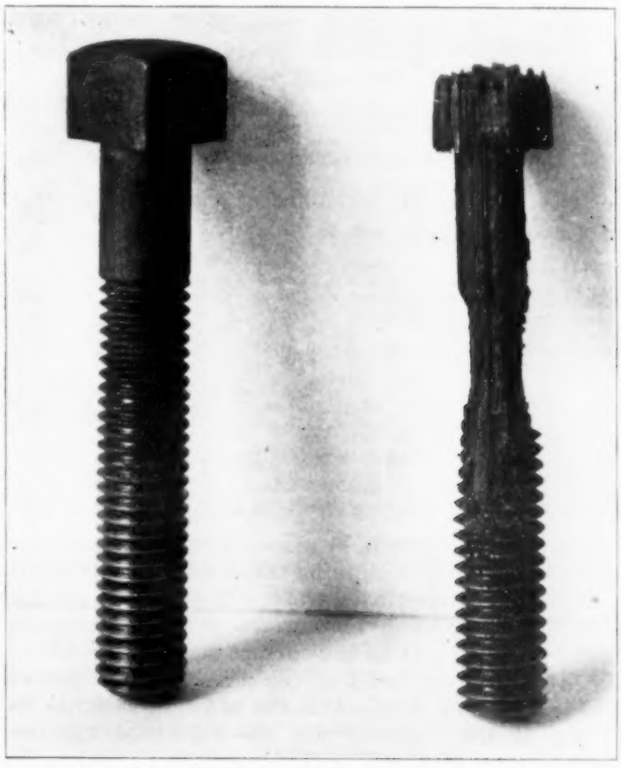


FIG. 1.

At left, open-hearth iron with no slag inclusions; at right, puddled iron with slag dissolved out.

uous and any oxidation of the metal as it penetrates inwardly from the surface must meet layers of slag. In the other direction, however, that is, in a direction parallel to the layers of slag, the metal is continuous and as it penetrates will not meet these layers of slag or cinder. Hence, if corrosion is retarded by slag inclusions, one would expect to find that transverse sections of wrought iron will rust more rapidly than longitudinal sections.

"In order to test out this line of reasoning, transverse and longitudinal sections about $\frac{1}{16}$ inch in thickness were taken from pieces of Swedish iron and wrought iron and subjected to rusting at different times. The pieces were thoroughly annealed and the surfaces made smooth with emery cloth. After weighing and measuring the thickness of each piece in several places, all were placed in a wooden rack, and exposed to the weather.

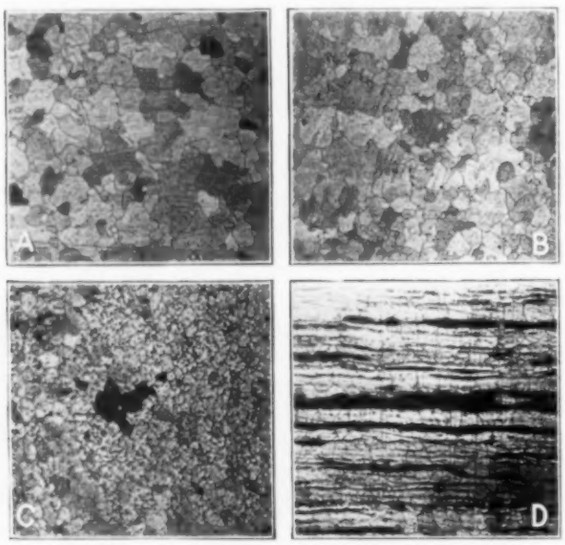


FIG. 2.

A—Transverse section, pure open-hearth iron. × 60.
B—Longitudinal section, pure open-hearth iron. × 60.
C—Transverse section, puddled iron. × 60.
D—Longitudinal section, puddled iron. × 60.

"The analysis of the different irons, the exposure data and the results are as follows:

	Sulphur	Phosphorus	Carbon	Manganese	Silicon	Copper
Steel	0.032	0.079	0.08	0.56	.....	None
Wrought iron (A)	0.044	0.132	0.015	0.095	0.193	None
Wrought iron (B)	0.020	0.100	0.020	0.038	0.180	None
Swedish iron	0.015	0.052	0.015	0.011	0.050	None
Wrought iron (C)	0.026	0.115	0.04	0.05	0.210	0.10

	Time Exposed	Transverse Section Loss in Weight	Transverse Section Depth Pits	Longitudinal Section Loss in Weight	Longitudinal Section Depth Pits
Steel	.....	.....	.....	.....	.....
Wrought iron (A)	6 mos.	0.1178	0.035	0.1101	0.033
Wrought iron (B)	6 mos.	0.0791	0.044	0.0789	0.041
Swedish iron	6 mos.	0.1068	0.026	0.1333	0.026
Wrought iron (C)	2 years	0.153	0.020	0.154	0.025

The loss in weight is in grams per square centimeter and was obtained by cleaning the rusted specimens with a solution of ammonium citrate. The depth of pits was obtained by grinding the surface of the cleaned specimens until the pits on the surface were removed.

"In view of the fact that the corrosion of transverse and longitudinal sections is the same as regards loss in weight and depth of pits, the conclusion has been reached that any superior resistance to corrosion that wrought iron may have is not due to slag inclusions but to some other causes, among which may be mentioned the purity of the iron."

The statement that ancient irons were of a nature and manufacture similar to puddled irons was contradicted by J. A. Aupperle, of the American Rolling Mill Co. He pointed out that prior to 1784, when Henry Cort invented the puddling process, all iron had been manufactured by the direct process, i.e., the ores had been smelted with the use of charcoal. After Henry Cort's invention of the puddling process, wrought iron was produced by this method, which gradually superseded the charcoal iron process. In the puddling process the iron ore is first reduced in a blast furnace, then cast in pigs which are remelted in the puddling furnace. Such iron, therefore, is produced by the indirect process, quite dissimilar to the earlier methods.

However, the speaker was in accord with Mr. Richardson's conclusion that purity in iron is essential to long life, quoting analyses of some rust-resisting irons.

"In our research work we have studied the gas content of iron and steel and the influence of gases upon the rate of corrosion. In the examples cited the nitrogen content will be found extremely low. In fact, I have never analyzed an ancient iron without finding low nitrogen. This is undoubtedly due to the method of manufacture. It is my opinion that the nitrogen content exerts a greater influence upon the rate of corrosion than any other element.

"In contrast with durable irons we have numerous examples of steel which failed in a very short time. All of those which failed in a short time were found to be high in nitrogen. We have had 26-gage bessemer sheets, which were exposed to the weather, fail within thirteen months; other sheets of the same gage lasted thirty-four months.

"In the following table will be found the analysis of a pipe and also a spike, which in addition to containing high nitrogen also contain a high percentage of carbon monoxide. I have also included the analysis of pure iron made in an open-hearth furnace for the purpose of showing that the nitrogen content in the above failures is ten times as high as the nitrogen content of pure iron. This comparison also shows that the carbon monoxide is several times higher in the pipe and spikes which failed than the pure iron.

	Failure of Pipe in Alkali Soil After 14 Mos.	Failure of Spike in Railroad Ties Arizona, After 9 Yrs.	Pure Iron Made in an Open-Hearth Furnace
Carbon	0.090	0.100	0.010
Manganese	0.357	0.405	0.025
Phosphorus	0.098	0.108	0.004
Sulphur	0.049	0.041	0.025
Silicon	trace	trace	trace
Copper	0.014	trace	0.040
Nitrogen	0.041	0.033	0.004
Oxygen	0.032	0.082	0.015
Carbon monoxide	0.052	0.058	0.015

"Based upon the data which we have accumulated, we find the gaseous impurities have a greater influence upon the rate of corrosion than the solid impurities.

"I have been able to dissolve the slag from a sample of puddled iron as shown in Fig. 1. Both the puddled iron and the iron made in an open-hearth furnace were submerged for half their length for 2 hr. in 25 per cent sulphuric acid. The pure iron bolt was attacked but slightly. The slag in the puddled iron bolt had dissolved to such an extent as to indicate the fibrous nature of the product. This test seems to confirm what Mr. Richardson has said about the slag offering no protection from a corrosion-resisting standpoint."

Longitudinal and transverse sections of both classes of materials are shown in Fig. 2.

Synthetic Acetic Acid and Acetone

Description of the Process and Method of Production of Acetic Acid, Acetates and Acetone From Calcium Carbide—Acetylene Generation and Catalytic Hydration—Oxidation of Acetaldehyde to Acetic Acid—Acetone

By J. T. ROONEY

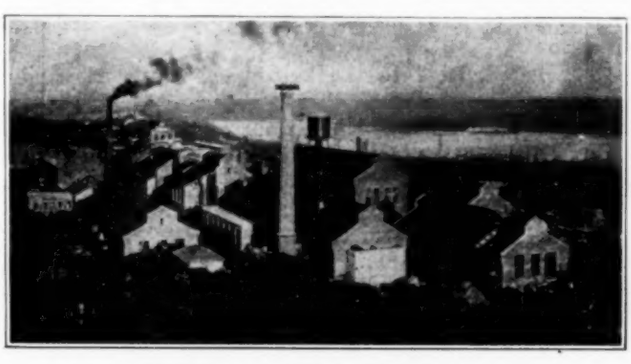
THE great war was responsible for very many interesting industrial developments in which chemistry played a leading part. The progress of hostilities created demands for some materials greatly in excess of their previous rate of production or even any preconceived ideas of war-time necessity.

The extravagant use of artillery by the British on the western front, using cordite as a propellant, required a great quantity of acetone for the manufacture of this explosive, and it was soon discovered that the supply obtainable from wood distillation was entirely inadequate and new possible sources of manufacture were eagerly sought.

Necessity is said to be the mother of invention and to know no law, and so the urgent demands of war gave birth to many new ideas and fostered many new developments. The manufacture of acetone was undertaken from a variety of new sources, including calcium carbide, molasses, kelp, grain, etc., with varying degrees of success. Probably the most interesting, from a chemical point of view, is that including the synthesis of acetic acid from calcium carbide, water and air.

The various steps in this process had been the subject of much research and several patents before the war, but little had been done up to that time on its commercial development. Subsequent events, however, provided a stimulus which resulted in the synthetic production of great quantities of alcohol, acetic acid and acetone in America, France, Switzerland and Germany.

The Shawinigan Water & Power Co. of Montreal, Canada, which controls a large power development and calcium carbide plant at Shawinigan Falls, was approached by the British War Ministry on the possibility of producing acetone synthetically at Shawinigan Falls. The result was that a subsidiary company called the Canadian Electro-Products was incorporated and, after six months of research by the staff of the new organization, construction was begun and in the following eight months a $2,000,000 plant covering fifteen acres was completed and working to capacity. The plant buildings are of brick, steel and fireproof construction throughout, the floors being of concrete and metal lath and the stairways of iron.



GENERAL VIEW OF THE PLANT

Early in 1918, the Imperial Munitions Board, owing to the great need for acetic acid in the manufacture of cellulose acetate for aëroplane construction, instructed the company to discontinue the production of acetone and to confine its efforts to making acetic acid only.

Reactions of the Process

The synthesis of acetone takes place in four steps:

The production of acetylene from calcium carbide.

$$CaC_2 + 2H_2O = C_2H_2 + Ca(OH)_2$$

The hydration of acetylene to acetaldehyde.

$$C_2H_2 + H_2O = CH_3.CHO$$

The oxidation of acetaldehyde to acetic acid.

$$CH_3.CHO + O = CH_3COOH$$

The formation of acetone from acetic acid.

$$2CH_3COOH = (CH_3)_2CO + CO_2 + H_2O$$

Development of the Process

After the nature and extent of the reactions involved in the various steps of the process had been thoroughly investigated in the laboratory, a small building was allotted for an experimental plant, and in this development proceeded on a semi-commercial scale. It was at this stage that most of the difficulties were encountered and overcome. One of the first problems was the selection of a suitable material for a vessel which would withstand the action of weak sulphuric acid with metallic mercury, and it was found that an acid-resisting silicon-iron was the only satisfactory medium.

Another problem which had to be solved early in the game was the preparation of the yellow mercuric oxide, which acts as a catalyst in the conversion of acetylene to acetaldehyde. This material was required in considerable quantities, and the process of making it from nitric acid and metallic mercury with subsequent conversion of the nitrate to oxide by ignition would have proved a troublesome and costly process on a large scale and consequently new methods of preparation were sought. The process finally developed, and with which very excellent results were obtained, was the electrolytic oxidation, at the anode, of metallic mercury to the oxide, using caustic soda solution as an electrolyte.

Owing to the difficulty of obtaining air-liquefying apparatus for the separation of oxygen from the atmosphere, attention was directed to the utilization of air directly for the oxidation of acetaldehyde to acetic acid, and after many experiments with various metallic containers, numerous catalysts, etc., the task was successfully accomplished. It was found that the reaction could not be controlled in iron, copper, etc., owing to the catalytic action of these metals which was responsible for several explosions at this stage, and it was eventually decided that aluminum was the only metal which could be safely utilized in this capacity.

For the conversion of acetic acid to acetone, numerous experiments were made with oxides and carbonates of calcium, magnesium, barium, zinc, manganese, etc., to determine the most suitable catalyst for the reaction, and the best results were obtained by use of hydrated lime containing a little magnesia.

As in every chemical development, a very considerable amount of work was required to determine the best operating conditions for every step of the process.

Plant Equipment and Operation

The hydration of the acetylene to acetaldehyde is carried out in Duriron kettles, 4 ft. dia. x 12 ft. high, built in circular flanged sections clamped together. In operation, a kettle is filled with water to about three-quarters capacity and sulphuric acid added to make a 6 per cent solution, then mercuric oxide charged in at regular intervals while acetylene is introduced at the bottom of the kettle and allowed to percolate upward through the solution. The mercuric oxide is kept in suspension by the action of the entering gas and by mechanical stirrers. These stirrers, three in number, have paddle blades perpendicular to the shafts, the latter extending to the bottom of the kettle, where they fit into guide sockets. Each stirrer shaft is supported from a collar at the upper end which revolves on ball bearings and is connected with bevel gears to a 7½-hp. motor bolted to a framework on the top of the kettle. The relative weakness of acid-resisting silicon-iron made it impossible to construct these stirrers entirely of this material, and as no other metal was adaptable to the purpose, the difficulty was ingeniously surmounted by the use of a steel shaft over which were fitted sleeves of Duriron, cast in sections with paddles and held tightly together by means of a nut threaded on the shaft.

A rubber gasket between each two sleeve sections prevented leakage of acid to the inner shaft. The lower end of the steel shaft was threaded into an iron nut cast in a piece of Duriron, against which the lowest sleeve fitted tightly.

Acetylene gas is admitted into the bottom section of a kettle through a perforated Duriron pipe and rises through the solution, where it is partially converted into acetaldehyde, the unaltered portion passing out with the aldehyde vapor at the top of the kettle and through condensers and scrubbers into a gasometer, from which it is returned by a Nash hydroturbine to the kettles. Additional acetylene is admitted to the system under pressure at the same rate as the gas is being converted. One charge is operated 50 hr., after which it is dumped and the acid and catalyst renewed. A temperature as nearly 70 deg. C. as possible is maintained in the kettle and the aldehyde, which is boiled off and condensed, runs to brine-cooled containers for storage.

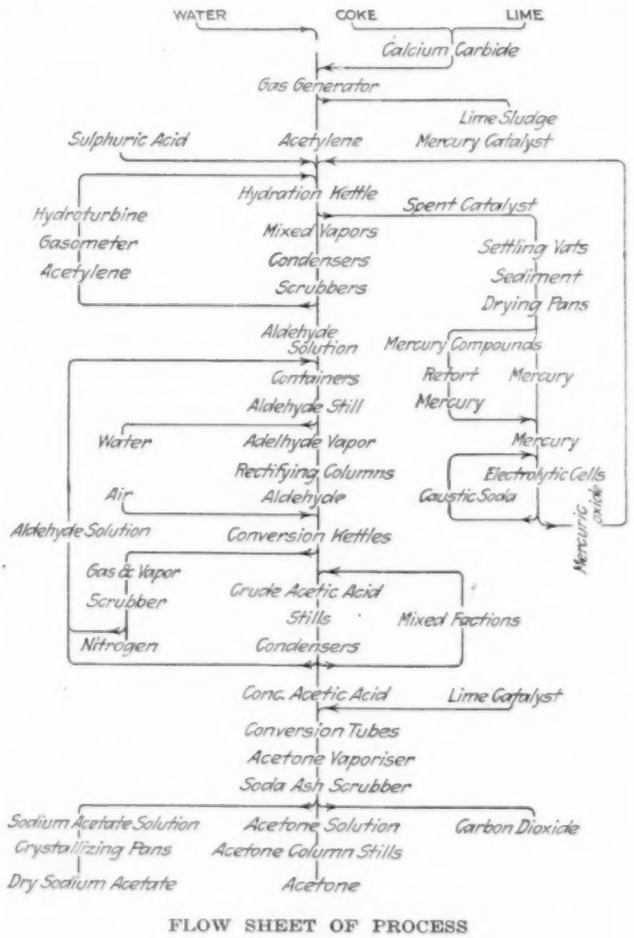
In December, 1918, a disastrous explosion, evidently due to a leakage of acetylene or aldehyde with accidental ignition, wiped out the building in which this part of the process was carried out. Several lives were lost and considerable damage was done.

Acetaldehyde Concentration

Crude aldehyde (from the previous step of the process), a 35 per cent solution in water, is pumped from storage to the still house, where it is concentrated to 99 to 100 per cent and stored again in cooled wrought-iron containers. The motor-driven crude aldehyde pumps are controlled automatically by a float and trip-switch in a small supply tank at the top of the still house. The equipment in this building consists of continuous stills and rectifying columns of cast iron with automatic steam control regulated by vapor tension in the columns. The outlet at the top of the columns is connected to condensers, which are in turn vented to the atmosphere. The addition of a little fine chalk to the crude aldehyde feed neutralized the acidity and added considerably to the life of the apparatus.

Oxidation of Acetaldehyde to Acetic Acid

Pure acetaldehyde, in charges of 1,000 gal., is pumped into heavy iron kettles lined with aluminum, in which the conversion to acetic acid takes place. This part of the process requires the most careful attention of any owing to the extreme sensitiveness of the reaction



FLOW SHEET OF PROCESS

involved and the absolute necessity of the most accurate control. Manganese acetate, ground to 200 mesh, was found to be the most satisfactory catalyst for this reaction.

Air is admitted to the bottom of the kettle under high pressure, helping to keep the catalyst in suspension, and the oxygen is rapidly absorbed. The operation is carried out at a temperature of 60 deg. C. and under a pressure of 65 lb. per sq.in. in the kettle, the pressure being regulated by the rate of admission of high-pressure air and contraction of the outlet of the kettle. The temperature is kept down by circulation of cold water in coils inside the kettle. The dome of each kettle is connected with a set of reflux condensers, which returns liquid aldehyde through a seal to the bottom of the kettle.

The outlet from the kettle is carefully restricted to the cracking of a valve during operation, and the gases which escape pass through a large scrubber, which collects in water any aldehyde that may be carried out with the escaping nitrogen. For safety in operation, each kettle is equipped with duplicate thermometers and pressure gages, which are watched constantly by the operator. There is put into one charge 1,000 gal. of aldehyde, and it requires about 12 hr. to reach an acidity of 95 per cent in terms of acetic acid. It is then considered finished and is dumped. So completely is the oxygen absorbed from the air in this operation that the scrubber gas content seldom exceeds 0.1 per cent. In spite of every precaution, fatal explosions and fires have occurred in this building.

Acetic Acid Refining

The crude acetic acid containing small amounts of aldehyde, manganese acetate, water, etc., is refined by fractional distillation in copper stills with aluminum fractionating columns, dephlegmators and condensers. The aldehyde fraction comes off first and goes to the aldehyde storage; mixed fractions are run with a subsequent charge. Water-white acetic acid, 99.8 per cent pure, is produced by this distillation.

Production of Acetone

In this step of the process, vaporized acetic acid is passed through a heated tube containing a catalyst which effects the decomposition of acetic acid with the formation of acetone, the products passing through a hot scrubber containing soda ash, which converts the unaltered acetic acid into sodium acetate and allows the acetone to pass through into condensers, from which it is obtained in a 20 per cent solution. When this operation was tried on a large scale it was found that the larger conversion tube, measuring 12 in. dia. x 13 ft. in length, did not function so well as the experimental one which had been made from a 4-in. wrought-iron pipe. In the larger installation, steel tubes were used covered with asbestos and mica and wound with 290 ft. of No. 12 nichrome ribbon. The winding was made in several parallel circuits for convenience in temperature control. These tubes were packed with pumice on which the catalyst, hydrated lime, was deposited, but owing to the poor conductivity of the pumice it was impossible to maintain the required temperature of 485 deg. C. A central heating core was then added, but even this did not have the required effect, and the pumice was finally replaced with iron balls coated with lime. Seventy-two such conversion tubes were installed, requiring 12 to 15 kw. each for heating, and these gave a daily production of ten tons of acetone of great purity with an operating efficiency of 85 per cent for the entire period of production. It was necessary, in this process, to renew the catalyst about every two weeks.

Preparation of Mercuric Oxide

The yellow mercuric oxide catalyst used for the conversion of acetylene to acetaldehyde is prepared by the electrolysis of a caustic soda solution in circular cast-iron cells, 6 ft. dia. x 15 in. deep, having the inside walls lined with cement.

A layer of metallic mercury on the bottom of the cell serves as anode. A large sheet-iron cathode, like a spider web in appearance, is suspended below the surface of the electrolyte.

A stirrer revolves between the electrodes to remove the oxide formed from the surface of the mercury and to keep it in suspension. At the end of a run the oxide is washed from the cell with a hose and settled in vats, from which it is used directly in the wet condition. The caustic soda is used repeatedly.

Recovery of Mercury

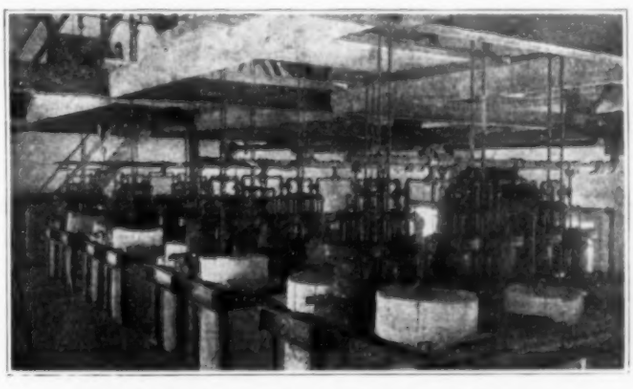
The recovery of the mercury was another problem involving many difficulties and for which quite an extensive equipment was required. When a charge containing the spent catalyst is dumped from an acetylene conversion kettle it is settled in conical wooden vats, after which the supernatant liquid is siphoned off and passed through a series of settling tanks to catch all the mercury possible. The sediment remaining in the conical vats, consisting of metallic mercury, mercury compounds, etc., is then neutralized with soda ash and charged into covered, steam-jacketed drying pans fitted with stirrers and operated under a full vacuum. When the contents of these pans have been dried, metallic mercury is run off and the remaining material then charged with reducing agents into retorts for distillation. These retorts are oil-fired and the pots were at first made of cast iron, but this material had a very short life and the expense of renewal was excessively high, but later nichrome alloy pots were tried out and gave more efficient service in spite of the greater initial cost.

The extensive handling of mercury in the various steps of the process was the cause of much sickness until proper precautions had been studied and enforced.

A Notable Achievement

This undertaking of the Shawinigan Water & Power Co. was a notable achievement, both from the point of view of the success attained and the remarkably short transitional period from the laboratory research stage to one of large-scale production. It is also a striking example of the major rôle played by chemistry in modern warfare and a proof that Canada did her "bit" in the laboratory as well as on the battlefield. The frequent necessity for use of the regulation army gas mask for protection against lachrimatory gases such as croton-aldehyde, etc., contact with the poisonous mercury catalyst and the ever-existent danger of explosion or fire presented a parallel for life in the trenches and a casualty list equally as deserving of an enduring place on the roll of honor.

When the United States Government entered the war and planned a huge aërial program, great quantities of acetic acid were required for manufacture of cellulose acetate varnish, and it was found expedient, by



CONVERSION TUBES AND EVAPORATION POTS

arrangement with the Shawinigan Water & Power Co., to duplicate, on the spot, the plant at Shawinigan Falls.

This new plant, called the American Electro-Products Co., was about completed and ready for operation when the armistice was signed. So well had the development of the process been carried out in the beginning that, even with the experience gained by a year's operation, only minor variations from the original design were found necessary in building the second plant. The combined plants have a capacity of more than fifty tons of glacial acetic acid per day.

Conclusion

The products of the various steps of the process form possible bases for the manufacture of an unlimited variety of valuable organic chemicals, and the apparatus, in excess of that required to supply a normal acetic acid demand, might readily be adapted to the manufacture of countless new products.

In cost of production, the synthetic process, when associated with the carbide industry, can at present about hold its own with the wood-distillation process and should ultimately entirely displace the latter.

Extensive research by a large staff is now being carried on in the well-equipped laboratories and experimental plant of the Canadian Electro-Products Co. and the company looks with every confidence to the future.

Canada's Foreign Trade for 1919

THE value of Canada's foreign trade in the year ended Dec. 31, 1919, exceeded that of the previous twelvemonth by $82,049,160. Imports in 1919 aggregated $941,007,700, or $30,858,560 more than in the preceding year; exports, $1,241,085,606, or $41,449,143 more; and re-exports, $53,834,766, or $9,741,457 more. With the exception of the record year of 1917, the values for 1919 exceeded those of any other year of the last decade, as Table I shows.

The balance of trade in favor of the Dominion in 1919 was $353,912,672. In trade with the United States, however, Canada had an adverse balance of $285,893,931. That adverse balance has been a potent factor in determining the rate of exchange between the two countries.

The extent to which the various countries of the world participated in Canada's foreign trade during the past three years can be seen from the totals presented in Table II.

Canada during the past year extended credits of $25,000,000 each to Belgium, Rumania, Greece, and France. Orders were placed under these credits as follows: Belgium, $1,734,295; Rumania, $22,373,467; Greece, $8,118,940; France, $5,519,047.

The development of the market for Canadian goods in the United States is emphasized by the figures for the year just closed. The returns show total exports from Canada to the United States for twelve months ended Dec. 31 last amounting to $454,686,294, compared with $433,182,140 in 1918, an increase of $21,504,154, and with $401,479,287 in 1917, an increase of $53,207,007. Imports from the United States for the year at $740,582,225 show an appreciable decline as compared with 1917, when they were $829,847,747, a decrease of $89,265,522, but, compared with 1918, there was only the small decline of $756,079.

This situation is in marked contrast to the trade done with the United Kingdom. For the year the exports to Great Britain and Ireland amounted to $528,035,514, compared with $568,820,873 in 1918, a decrease of $40,785,359, and, compared with $873,706,892 in 1917, a decrease of $345,671,378. Imports from the United Kingdom for the past year at $87,516,819 were higher than in 1918 by $14,637,710, but were lower than in 1917 by $3,619,909.

The large decline in exports to Great Britain is explained by the elimination of huge shipments on war account in both 1917 and 1918, though it is encouraging to note that the shipments of peace-time goods are now showing a substantial, if gradual, gain.

TABLE I. CANADA'S IMPORTS AND EXPORTS, 1910-1919

Calendar Years	Merchandise Imports			Merchandise Exports		
	Dutiable	Free	Total	Canadian Produce	Foreign Produce	Total
1910	$269,759,731	$165,441,076	$435,200,807	$279,859,593	$15,554,838	$295,414,431
1911	320,452,211	183,036,549	503,488,760	279,446,816	17,121,211	296,568,027
1912	418,021,349	218,668,576	636,689,925	341,980,882	20,984,698	362,965,580
1913	438,539,132	221,364,984	659,904,116	436,218,067	24,301,179	460,519,246
1914	302,516,964	179,431,624	481,948,588	379,295,854	49,019,658	428,315,512
1915	261,842,173	189,042,855	450,885,028	614,129,845	39,358,567	653,488,412
1916	422,173,311	345,203,358	767,376,669	1,091,706,463	20,738,599	1,112,445,002
1917	557,636,509	448,394,360	1,006,030,869	1,547,340,855	46,155,194	1,593,496,049
1918	511,105,417	399,043,723	910,149,140	1,199,636,463	44,093,309	1,243,729,772
1919	607,452,288	333,555,412	941,007,700	1,241,085,606	53,834,766	1,294,920,372

TABLE II. ANALYSIS OF CANADA'S FOREIGN TRADE

Countries	Imported from			Exported to		
	1917	1918	1919	1917	1918	1919
United Kingdom	$91,136,728	$72,879,109	$87,516,819	$873,706,892	$568,820,873	$528,035,514
Australia	979,018	6,084,963	1,523,106	8,145,426	11,169,474	13,501,923
British East Indies	13,311,740	17,027,295	13,411,326	4,131,651	2,814,378	6,508,195
British Guiana	8,120,098	5,088,972	8,065,019	2,070,809	2,216,001	2,925,728
British South Africa	510,765	1,331,842	668,723	4,881,526	9,704,215	10,504,740
British West Indies	11,117,883	8,928,909	10,544,539	6,319,644	8,353,709	11,321,072
Hongkong	1,712,920	2,343,958	1,779,067	1,000,475	968,766	437,458
Newfoundland	2,743,597	3,287,340	2,056,900	8,723,489	10,876,310	16,464,383
New Zealand	3,351,394	7,014,313	2,838,863	4,181,290	4,605,116	7,362,218
Other British Empire	1,591,579	1,371,069	1,152,732	1,519,281	2,505,588	7,401,925
Argentina	1,761,799	1,726,489	1,746,044	1,516,914	2,683,179	6,887,395
Brazil	1,036,788	1,128,616	1,607,970	1,088,269	3,825,859	2,141,232
China	1,268,662	1,867,405	1,245,740	1,471,803	2,934,663	4,819,534
Cuba	1,047,062	2,034,654	12,565,712	3,640,784	4,879,779	5,642,675
France	5,715,770	3,754,761	6,784,860	200,289,282	97,378,476	65,114,419
Italy	855,900	642,071	706,358	2,318,838	9,426,652	16,755,951
Japan	11,100,455	13,184,893	12,697,203	3,760,267	10,624,274	7,569,810
Netherlands	1,130,855	582,507	1,504,390	2,102,428	597,008	3,983,389
United States	829,845,747	741,336,304	740,580,225	401,479,287	433,182,140	454,686,294
Other foreign countries	17,692,109	18,533,670	32,012,104	14,992,500	12,070,003	69,022,771
Total	$1,006,030,869	$910,149,140	$941,007,700	$1,547,340,855	$1,199,636,463	$1,241,085,606

The Commercial Synthesis of Sillimanite*

A Description of a Cupola Process for Fusing Alumina and Silica to Form Sillimanite Crystals — Reactions Consist of Forming Carbides Under Reducing, and Combusting Them Under Oxidizing Conditions

BY ANDREW MALINOVSZKY

VERY little work has been done on the conversion of the double oxides of alumina and silica or alumina and magnesia into stable crystal phases such as sillimanite and spinel. Many ceramists have tried to mix, without actually fusing, alumina and silica, molecule for molecule, to obtain sillimanite, or alumina with magnesia, to form spinel. Stoichiometrically these mixtures may be made to represent the analytical composition of sillimanite and spinel crystals perfectly, but physically such mixtures are far from having the stable properties of either. The products obtained in such a manner exhibit no more stability than their individual components.

No advantage whatsoever can be claimed for mere physical mixtures of alumina with silica, or alumina with magnesia. The real value of such a combination is obtained only if the components are interdissolved by fusion. Solidifying from solution, the molecules arrange themselves into their stable crystalline phases.

It should be clearly understood that when alumina and silica, or alumina or magnesia, are mixed and exposed, after they have been shaped into brick, to any temperatures lower than fusing, neither new molecular combinations nor crystalline compounds will be made. When such a heterogeneous mixture is made into refractories and placed in service in a furnace, where it is exposed to sudden thermal changes, to slag, to alkaline vapors, or to any other destructive agents existing in a commercial furnace, it will be quickly acted upon and soon destroyed.

FLUXED SILLIMANITE NOT DESIRABLE

The suggestion has been made by a few ceramists that old glass pots be used, pots in which the free silica has been dissolved by the alkalis of the glass, leaving behind a magmatic solution from which sillimanite crystals have formed after the pots were cooled. The addition of such sillimanite is of no more value to the newly built pots than that of common grog. It stands to reason that sillimanite crystals produced from such a magmatic solution in the intimate presence of fluxing solvents are not stable, and their presence can then be of no value. Sillimanite crystals formed under such conditions will be dissolved well below their fusion temperature of 215 deg. C. by the fluxing action of the intimately associated low melting point substances, if heated to a temperature where the adjacent material from which the sillimanite crystals separated out is in the liquid state. In other words, the sillimanite crystals formed as stated above will be attacked by the surrounding material whenever the temperature at which it becomes liquid is reached. It will then act as a solvent for the sillimanite crystals, and the whole mass will fuse at a temperature far below the fusing temperature of sillimanite.

Stable sillimanite or spinel crystals are obtained only when their components are liquefied at the fusing temperature of alumina and silica, or alumina and magnesia. The fusion should not be produced by any fluxing agent, but only under the action of heat at the required temperature of approximately 1,815 deg. C. or above. For illustration, take porcelain bodies containing sillimanite crystals, concerning which many theories have been advanced. Those investigators who came to the conclusion that sillimanite crystals are formed only from an acid solution of silica and alumina, and not from a viscous slag, have demonstrated the actual facts. Adding lime or magnesia does not develop the crystals; it only promotes the liquefaction of the magma. If the body or mix should be brought into a liquid state without the addition of these bases the crystals would have been better developed.

FACTORS INFLUENCING THE DEVELOPMENT OF SILLIMANITE CRYSTALS

Many experiments along this line have demonstrated that the presence of a high percentage of lime actually retards the development of the sillimanite crystals. Most authors and investigators have laid great emphasis on the importance of feldspar as favoring the development of sillimanite crystals, for without feldspar no sillimanite crystals seem to be formed in a porcelain body. This statement holds good for porcelain bodies, glass pots and firebricks, as the feldspar dissolves the kaolin and also the flint. At the same time, with porcelain it is demonstrated that lime acts as a retarder in the formation of sillimanite crystals. For in the glass covering the porcelain bodies, sillimanite crystals are never found, but close under the glass more sillimanite than anywhere else in the same body is found to occur.

Sillimanite crystals much larger in size (length and diameter) can be produced without the presence of feldspar, mica, lime or any other fluxing material than when these materials are present. It should be borne in mind that if the components of sillimanite are heated up to their boiling temperature, as is the case in the process about to be described, it is evident that considerable molecular activity must be produced. In building up the sillimanite crystals, the molecules of alumina and silica must follow their turn in the force of the molecular attraction. Thus they become regularly arranged groups of molecules in harmonious vibrating or oscillating relation with one another, and so one molecule after the other comes into equilibrium with one another until the whole magma has been formed into a solid form of a crystalline structure.

The method by which artificial sillimanite crystals are produced consists of crushing aluminous minerals from

*An excerpt from the paper read by the author, entitled "Fused Artificial Sillimanite," before the American Ceramic Society, Philadelphia, Feb. 23, 1920.

1 in. in diameter down, and smelting in a cupola furnace together with a suitable reducing agent in a required amount. It is possible to regulate the volatilization of the silica by proportioning the amount of reducing agent, so that it shall be sufficient to reduce all or a fraction of the silica, leaving only a part of the silica unreduced, so to convert all the charge into sillimanite upon oxidation and fusion.

For instance, the crushed raw material is mixed with coke, the carbon being approximately in molecular proportion to the oxygen contents in the rock or minerals, as indicated in the following equations:

$$2Al_2O_3 + 4SiO_2 + 14C = Al_4C_3 + 4SiC + 7CO_2$$

which upon combustion will give the following with a heat of reaction that will fuse the products:

$$Al_4C_3 + 4SiC + 14O_2 = 2Al_2SiO_5 + 2SiO_2 + 7CO_2$$

The proportion of the mixture is varied, as an excess of carbon over the calculated amount of silica is necessary in order to complete the reductions, as the raw material may contain some iron, lime, etc. On the assumption that the above reactions take place, it is evident that everything present is reduced to carbide. After the carbides are formed, they dissociate, though less rapidly than in the pure state. It depends on the ratio of the combined carbon and the effect of silicon and aluminum upon the quantity and condition of carbon. When SiC gives up its Si, leaving behind C, the silicon ignites spontaneously on coming in contact with the air blast, forming first SiO then SiO_2.

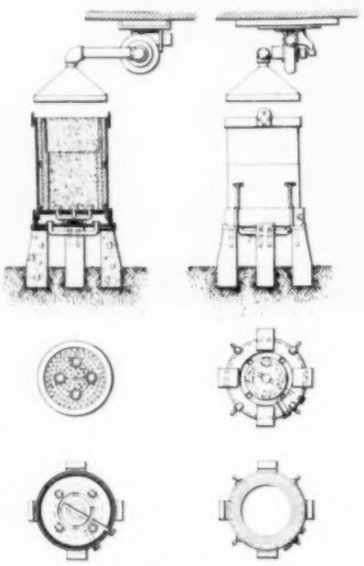


FIG. 1. FURNACE SECTIONS

The reactions between silicon and oxygen are very violent and much heat is produced by the combustion. If iron is present, it usually alloys with silicon and it is either volatilized or sinks to the bottom of the furnace.

Furnace Used for Fusion

Sections of the furnace are shown in Fig. 1. The outside of the furnace is of common iron such as an old boiler shell, or an old smokestack can be used. This is lined with good firebrick. The bricks are then protected with a layer of about 4 in. of the pulverized material to be fused. A tapering mold is placed inside the furnace and the raw material is rammed all around between the furnace and the mold to about 1 in. thick on the top. This will protect the firebrick and at the same time prevent the fused mass from adhering to the firebrick, so it can be discharged freely in a very short time. When the ramming is finished the mold is removed. The gratebars are covered with a layer 1 ft. deep of large lumps of coke. These lumps of coke are placed on the grate bars to protect them from the heat of the fusion zone. Coke is the best fuel for the process, as it does not crush or disintegrate and carries the weight of the charge better than coal. The coke, which has about 44 per cent of voids, proves advantageous in preheating the air.

A 3-ft. layer of fine coke is placed over the coarse layer, then a little kindling wood, on top of which about 16 in. of fines are spread and the fire lighted. The blower is started very slowly at first. After the coke is ignited, the crushed raw material mixed with the crushed coke is fed into the furnace and the speed of the blower is gradually increased to furnish about 18,000 to 28,000 cu.ft. of compressed air per hr. under from 3 to 6 lb. per sq.in. of pressure. In about 2 hr. the charge sinks down and the gases burn in flames above the surface. The blast of the compressed air is forced through the 64-in. fuel bed of coke, being

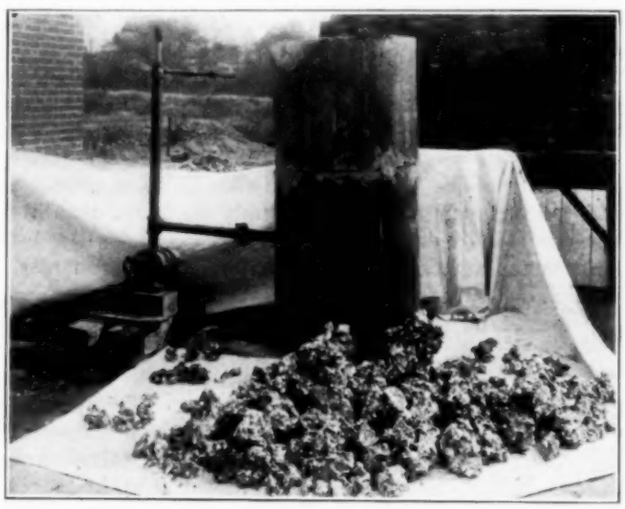


FIG. 2. CUPOLA AND BLOWER, REMOVED SILLIMANITE CHARGE

very well preheated, and so forced through the hot reacting zone under favorable conditions.

The silica is observed condensing on the furnace wall. This period is characterized by the yellow flame coming from the furnace, which later changes to violet and then white. It is very important in this process to have the heat come from the bottom of the furnace. Enough fuel should be bedded at the start to supply the whole process. The furnace must be maintained under such reducing conditions in the beginning as to gradually convert all the elements present to carbide. It should be understood that reduction takes place only at temperatures where solid carbon takes up oxygen from the material. After 3 or 4 hr. the whole charge is brought to a dazzling glowing white heat, the yellow and violet flames indicating the combustion of the Si to SiO and then to SiO_2.

The contents of alumina and silica boils violently, which is made evident by the roaring noise inside the furnace. The silica is volatilized in dense bluish white and later brownish fumes for about 2 hr. After 5 or 6 hr. the reactions are completed and the air is blown into the cupola through the cooling fused mass in order to produce cells resembling diatomaceous earth. The specific gravity of this fused mass varies from 2.62 to 2.86.

The furnace is provided with an exit pipe through which the fumes of silica, potash, sodium, etc., if present, together with the other gases, are withdrawn to a settling system, where they are separated.

From this process it is possible to effect a complete separation between the fused mass, alkalis and silica, if desired, which is a more economical process than the electric furnace. The hood of the furnace can be removed freely to both sides and also lowered or raised. The hood is suspended above the furnace, and suction is applied so as to collect all the fumes. By this means the cupola is aided by a blast at the bottom and suction at the top.

The fused mass can be removed in different ways, as the cupola is so designed as to accomodate varying conditions. The mass can be removed at the bottom with the cupola in place, or the cupola can be removed and leave the chilled fused mass standing in place on the grate bars, or the mass and cupola can be removed, and another cupola, all ready charged, set up on the place, and another operation can be started. With this system a continuous process is established.

Fused Sillimanite

After the fused sillimanite is removed from the furnace it is broken up in a jaw crusher and then reduced to the required fineness. Any metallic iron present is separated out by a specially designed magnetic device.

FIG. 3. SILLIMANITE PRODUCED FROM ST. LOUIS FIRE-CLAY. × 114.

The fused sillimanite obtained by this process is a very stable compound and highly refractory, free from uneven expansion and contraction strains at any temperature.

This process of making artificial sillimanite crystals has also developed some doubts as to whether the crystal development is due only to the influence of slow cooling, as has always been hitherto believed. In the science of petrology it is taught that the volcanic rocks which were cooled on or near the surface of the earth solidified so quickly that the rocks show very small crystals or none at all, often with open texture. Obsidian, which is a glassy lava sometimes called volcanic glass, resembling bottle glass, showing no crystal development, is a typically extreme case. It is composed of from 65 to 78 per cent of SiO_2, from 12 to 17 per cent of Al_2O_3, the remainder being different oxides of iron, calcium and others. The plutonic rocks, on the other hand, solidified deep below the surface, had time to cool slowly and develop a coarse crystalline structure with a very close texture.

The cooling rate theory is not checked with this process, where the mass is brought to the boiling point in from 5 to 6 hr. and cooled down in 1 hr. by a cold blast with 5-lb. pressure to a porous mass resembling pumice in its appearance, having a coarse crystalline structure with the largest sillimanite crystals ever produced. The accompanying illustration, Fig. 3, demonstrates the development of sillimanite crystals from fire clay. The square needle-like formation is very distinctly shown.

Production of Turpentine From Douglas Fir Pitch

Old growth yellow fir stands in certain timber districts of the Northwest contain a large number of what are known as "pitch trees." These trees are usually alive and free from noticeable decay, but frequently rough, burly and quite often twisted or bent well up the trunk, and contain, within a distance of several inches from the surface, pockets or seams filled with pitch. The pitch can be drained from the trees by boring into the seams with an auger, and the pitch collected in receptacle provided for this purpose.

The Northwestern Turpentine Co. has begun operations in a small way in collecting pitch from fir stands and in the production of turpentine and rosin. The pitch is collected from timber under lease, providing that all holes bored in trees shall be plugged after the pitch is removed and that all possible efforts be made to prevent fire hazard. The pitch is transported to Portland in barrels for treatment. The turpentine is recovered from the pitch by distilling with live steam. After the turpentine is removed a commercial grade of rosin is obtained from the residue. The pitch will contain about 25 per cent by volume of turpentine, and about 70 per cent by weight of rosin. In addition it is possible to obtain a small amount of "balsam."

Artificial-Silk Manufacture in Great Britain

The manufacture of artificial silk is being undertaken by the British Cellulose & Chemical Manufacturing Co. at its factory at Spondon, near Derby. Samples of silk thread produced at Spondon have been submitted to weavers, who state that it is of such texture and quality that when converted into articles of clothing they will have the appearance and finish of natural silk. When fully developed the factory at Spondon will employ a large number of workers and produce nine tons of artificial silk a day. Other products which the company is manufacturing, or intends to manufacture. according to the London press, include non-inflammable films, synthetic perfumes, and aspirin; of the last named, six tons per week is being turned out from the company's works.

Mexican Commercial and Industrial Exposition in 1921

The Ministry of Industry, Commerce and Labor has begun preparations for a commercial and industrial exposition to be held in Mexico City in September, 1921, in commemoration of the first centennary of Mexican independence. According to the data given to the press, the exposition will be entirely national in character, and will be confined to exhibits of Mexican raw materials and manufactured products. Invitations are to be extended to all foregin Governments and to chambers of commerce of the principal cities to send representatives to attend the exposition.

Legal Notes

By Wellington Gustin

A Lesson on Filling Orders

In an action by the Burley-Winter Pottery Co. against the Onken Bros. & West Co., the Supreme Court of Wyoming has affirmed the judgment against the pottery company. (183 Pac., 747.)

The pottery company manufactures pottery, crockery, glassware and similar products at Crooksville, Ohio. It charged that it sold and shipped the wholesale house in Wyoming a car of stoneware on a written order.

On the trial the defendant objected to the introduction of the order as evidence on the following grounds:

1. That it is not shown that the person signing the same had any authority to give the order.
2. That the alleged order is void for uncertainty.
3. That it fails to disclose the price of the goods.
4. That there is no sufficient description of the goods.
5. That the order, being for more than $50 is void under the statute of frauds.

Since this contract was one coming under the statute of frauds the order was not admitted and plaintiff was unable to prove its case.

The provisions of this statute of frauds, which should be known and committed by every business man, are:

Provisions of Statute of Frauds

"Any contract for the sale of goods, chattels or things in action for the price of $50 or more, shall be void, unless:

"First. A note or memorandum of such contract be made in writing and be subscribed by the party to be charged thereby; or

"Second. Unless the buyer shall accept and receive part of such goods, or the evidences, or some of them, of such things in action; or

"Third. Unless the buyer shall at the time pay some part of the purchase money."

A Sales Contract Must Be a Signed Memorandum of Sales

The order offered in evidence called for "One car stoneware as per orders shown for same at ½c. per gal. less than prices sold at" and was signed "Onken Bros. & West Co., Successors to J. E. West Co., Inc., per E. W. Elder."

Plaintiff charged that the goods were sold by its salesman at an agreed price. But the Supreme Court said that in the order, as offered in evidence, the description of the subject-matter of the contract is too indefinite to fulfill the requirements of the statute. "One car stoneware may mean any kind or several kinds of stoneware, and the property could not be identified without other evidence. Nor does the additional statement, 'as per orders shown for same,' render the description of the property any more definite. The names of the parties giving the orders are not stated; but, if that had been done, the orders referred to were not offered in evidence. The order offered in evidence not being such a memorandum as is required by the statute, it was properly excluded. In addition to the insufficiency of the memorandum, there was no competent evidence of a delivery. The only evidence of a delivery was the testimony of the salesman who took the order that to the best of his knowledge the goods, the carload, was shipped according to the orders he had taken. But he admitted he had no personal knowledge of the shipment, was not present, and in fact knew nothing about the shipment."

Rickey vs. Moon Clay & Kaolin Co.

The Court of Errors and Appeals of New Jersey has affirmed the decree of the Court of Chancery in favor of Walter H. Rickey against the Moon Clay & Kaolin Co. and others. It appears that Rickey obtained an option agreement from defendant Moon in 1913 whereby Moon agreed to sell his clay lands in Hamilton township at any time within two years for $6,000 per acre for the best clay lands and $1,000 per acre for the balance. This option was extended and Rickey interested defendant Muschert and persuaded him to secure a loan of $3,000 upon promise to pay Muschert one-tenth part of the profits on the option agreement. Then Rickey got a commission agreement from Moon wherein the latter agreed to pay 10 per cent commission upon all sales of his land. Thereafter the complainant Rickey and Muschert and J. L. Conard entered into what was called the three-party agreement wherein it was stipulated that Muschert was to hold the Moon-Rickey agreements for the benefit of the three, subject to the lien of the loan mentioned. Rickey and Conard were to give their attention and efforts, Conard his professional skill as a lawyer, in advancing the enterprise, which was understood to be defending condemnation proceedings of the Pennsylvania Railroad. Out of the profits Muschert was first to retain $10,000, made up of the $3,000 advanced as a loan, $5,000 advanced to Conard and $2,000 to be later advanced. The agreement then provided that all of the profits should be divided among the three, share and share alike, after the deduction of the $10,000 above mentioned.

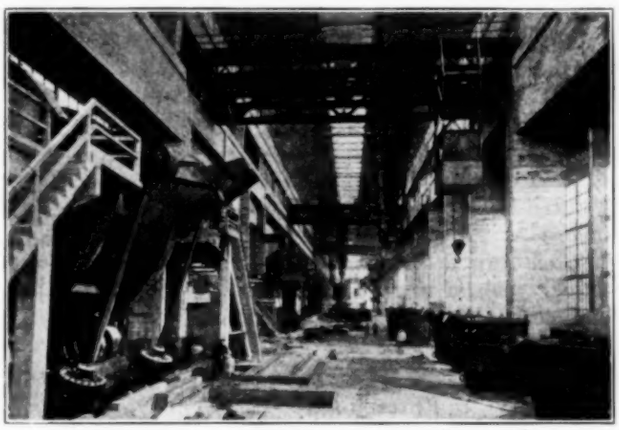
The condemnation proceedings failed of realization, and then Muschert, Conard and Moon formed the Moon Clay & Kaolin Co. and took over the clay lands for $206,000 of the capital stock of the company, under arrangement with Moon that he was to sell his holdings to Muschert and Conard for about $50,000. The clay company is now owned by Muschert and Conard, and is operating the clay pits. The complainant Rickey was not permitted to participate. He was practically frozen out, said the court. He then filed his bill to impress the trust of the three-party agreement and for an accounting.

Agreement Involved

The defendants Muschert and Conard answered setting up Rickey's 10 per cent commission agreement, and claimed that they were operating under it in connection with the three-party agreement. They said they were willing to assume Moon's obligation to pay the commission on a sales price of $206,000 to be divided equally between the complainant Rickey and Conard and Muschert, after deducting the $8,000 advances of Muschert. The agreement called for $10,000 to be deducted in favor of Muschert, but this included $2,000 which he was later to advance but did not. The three-party agreement shows clearly the final arrangement of the parties, said the court, and this was that all over the $8,000 was to be divided share and share alike. One-third was, therefore, adjudged to Rickey.

Synopsis of Recent Chemical & Metallurgical Literature

Large Mixer in New French Steel Plant.—*Engineering* (London) has presented considerable information regarding the new modern steel plant of the Société Normande de Métallurgie, Caen, France, in its issues, vol. 107, p. 136, vol. 109, pp. 180 and 292. The accompanying figure is an interior view of the craneway covering the casting pits for open-hearth furnaces, arranged in the left background. Nearer is the pouring side of a 700-ton mixer, for use as a reservoir for the bessemer converters. The mixer itself is 4.83 m. diameter, 8.23 m. long inside brick lining (15 ft. 10 in. x 27 ft.), fired by blast-furnace gas and hot blast from a regenerative checkerwork. Besides main pouring spout there



MIXER IN A MODERN STEEL PLANT

is an auxiliary charging mouth on the same side, while opposite is the main charging mouth and a slag spout, all of which are closely fitted with covers. The block containing gas and air ports is on wheels so it can be moved away from the opening into the mixer, but sufficient clearance at the flue connection is left so that this device is not necessary. The view also shows the traveling mast cranes used almost exclusively about the plant for such purposes as stripping, soaking pit service, billet and charge box handling. The extensive use of reinforced concrete in the building construction may also be clearly seen.

Smelting and Refining of Cobalt Silver Ore.—At the Deloro Reduction Co.'s smelter, silver cobalt ore is smelted in a blast furnace (run with 6-8 oz. blast pressure on account of the large proportion of fines), the charge being calculated to furnish speiss and a neutral slag. The speiss contains Co, 22-25; Ni, 16-18; As, 25; Fe, 18; S, 7; Cu, 1 per cent, and 1,000-2,000 oz. Ag per ton; it is first liquated to recover part of the silver, then ground, roasted, chloridized, washed with water, and treated with cyanide. The silver is precipitated from the solution with aluminum dust, the cyanide being almost quantitatively regenerated. The liquated and the precipitated metal are melted in an oil-fired furnace which is tilted backward into blowing position; the metal after 3 hr. blowing is 992-995 fine, and is refined by another melting. The desilverized speiss is sulphatized and leached; the liquor is first freed from copper and iron, cobalt precipitated with hypochlorite solution, and nickel, after removal of the cobalt, with milk of lime. The hydroxides are filter-pressed, washed, and dried ready for sale, or mixed with charcoal and reduced; the crude metals are separated magnetically from excess of carbon, re-melted in electric furnaces, and granulated by pouring into water. The dust and fume from the various furnaces, collected in a baghouse, are heated in a coke-fired reverberatory, and the pure arsenic trioxide condensed in chambers. The clinker from this operation goes back to the blast furnace for the recovery of silver.—S. B. WRIGHT, *J. Soc. Chem. Ind.*, vol. 38, p. 77A.

Canadian Mineral Production for 1919.—A digest of the 1919 statistics of the Canadian Department of Mines is given in the *Canadian Mining Journal*. The year has been one of transition from a war to a peace basis and the difficulties of making the necessary adjustments have been aggravated by social unrest and by strikes, these resulting in a decrease in the production of metals, coal and minerals during the year. On the other hand, structural materials, asbestos, gypsum and salt showed increases.

The value of products classified as structural materials and clay products was $25,755,000; as non-metallics, $74,919,000; as metallics, $72,402,000 — a total of $173,076,000, a decrease of $38,226,000, or 18 per cent, from that of 1918. The greatest decrease was in the production of nickel and copper; the decrease in value of the products classified as metallics amounted to 37 per cent.

In the amount of the individual metals produced, copper showed a decrease of 37 per cent; gold, with a total production of 767,167 oz., an increase of 10 per cent; lead, with a total production of 43,895,888 lb., a decrease of 15 per cent.

The production of nickel for 1919 was 44,452,953 lb., compared with over 92,000,000 lb. in 1918; of this, 5,063 tons was refined in Canada, compared with 1,204 tons in 1918. The new refinery of the British-American Nickel Co. at Deschenes, Que., which will soon be in full operation, will have a capacity of 7,000 tons of nickel and 3,500 tons of copper per year. There will also be a precious metal refinery, and platinum, palladium, iridium, gold and silver will be produced.

About 25 oz. of platinum and 62 oz. of palladium were produced during the year. Silver production was 15,675,134 oz., compared with 21,383,979 in 1918. The Ontario production was 76.1 per cent of the total. The zinc produced was 15,869 tons, a slight decrease.

The output of iron ore was, from the Canadian point of view, most disappointing, being the lowest recorded for nineteen years and amounting to but 195,970 tons. Of the iron ore charged to blast furnaces but 4.4 per cent, or 78,000 tons, was of domestic origin. Of the imported ore, 519,722 tons came from Wabana, N. F., and 1,154,473 from the United States.

Of asbestos, 153,069 tons of crude and milled fiber was produced, valued at $10,723,032, compared with 143,456 tons in 1918, valued at $8,870,707.

Canada produces less than half its total coal consumption. For 1919 the total used was 28,768,099 tons; of this, 13,586,300 tons was produced locally. The production of byproduct coke shows an increase during the year; sixty Koppers ovens were completed

at Sydney, twenty-five Willputte ovens at Sault Ste. Marie, and thirty Lomax ovens at Anyox, B. C. Imports of coke decreased from 1,165,590 tons in 1918 to 383,374 tons in 1919.

During the year there was a decided increase in production of all structural materials such as cement, clay products, lime, sand-lime brick and building stones.

Of salt, 148,302 tons was produced, which is an increase of about 10 per cent over 1918. The discovery of potash mineral associated with the salt deposit at Malagash is attracting considerable interest. The Brunner-Mond (Canada) Co. completed and placed in operation a plant at Amherstburg, Ont., for the manufacture of soda ash from brine.

The crude oil production was 240,970 bbl. (35 Imp. gal.—42 U. S. gal.), of which 90 per cent came from the oil fields of southern Ontario. Canada imported about 13,000,000 bbl. of petroleum oils, crude and refined, during 1919, an increase of 857,000 bbl. over the previous year.

Recent Chemical & Metallurgical Patents

Complete specifications of any United States patent may be obtained by remitting 10c. each to the Commissioner of Patents, Washington, D. C.

Reserve Dry Cell.—The cell consists of two parts—a zinc container which serves as the negative electrode when the cell is in use, and a bobbin or cartridge containing the positive carbon electrode and the usual mixture of carbon, electrolyte and manganese dioxide. This bobbin is provided with a thin paper wrapper and is dipped in a celluloid solution so that a waterproof coating is formed which prevents evaporation of the electrolyte. The upper part of the cartridge is sealed with pitch held in place by a band of zinc having a projecting peripheral bead which is designed to engage with a similar bead on the zinc container and thus lock the parts. The interior of the zinc container is coated thinly with flour paste. When it is desired to use the cell, the bobbin is taken out, the celluloid coating and paper wrapper removed and the bobbin replaced after having added sufficient water to the zinc container to thoroughly moisten the coating of flour, which now serves as a filler between the zinc and the mix. (1,329,946; HARRY D. BATCHELOR of Lakewood, Ohio, assignor to National Carbon Co.; Feb. 3, 1920.)

Stabilizing Lead Azide Detonators.—When mixed with blasting gelatine, lead azide may be handled safely and yet it retains its powerful detonating properties. From 1 to 20 per cent of blasting gelatine may be used, according to consistency desired. (1,329,525; WALTER G. HUDSON of Wilmington, Del., assignor to E. I. du Pont de Nemours & Co.; Feb. 3, 1920.)

Sodium Compound of Salvarsan.—The use of salvarsan is attended with certain disadvantages. The compound is sold as the dihydrochloride, and this acid must be exactly neutralized just prior to injection. The neutral solution cannot be kept, since oxidation proceeds rapidly, with the formation of a violent poison. Neo-salvarsan may be used directly, but is less effective. UMETARO SUZUKI of Tokio, Japan, prepares the sodium compound of salvarsan in the following manner: 5 g. of diamino-dihydroxy-arsenobenzene-dihydrochloride, $(C_6H_2NH_2OHAs)_2.2HCl$, is dissolved in alcohol and treated with sodium ethylate or methylate until a few drops give a clear solution in water. The whole liquid is poured into ether and 5 to 6 g. of yellow-brown precipitate is obtained. The operations should be carried out in a non-oxidizing atmosphere. The compound is soluble in water and physiological salt solution and contains from 22 to 23 per cent arsenic. It does not require neutralization and there is no tendency toward the formation of poisonous compounds through oxidation. (1,330,288; Feb. 10, 1920.)

Production of Cyanides.—Of the many compounds present in the reaction product of the Bucher process, only sodium cyanide is soluble in liquid ammonia. The extracted residue may be returned to the process. Indeed, the catalyst seems to improve. Prior to and during the leaching process, air must be excluded, as cyanate will be formed. This is also soluble in liquid ammonia. (1,329,652; JOHN C. CLANCY of Freeport, N. Y., assignor to the Nitrogen Corporation; Feb. 3, 1920.)

Rust-Preventing Solution.—Oxidation of iron and steel structures such as bridges and freight cars can be arrested by spraying with a solution composed of 70 parts of 50 per cent phosphoric acid, 20 parts of glucose or glycerine with sufficient water to make 100 parts, all by weight. After 24 hr. the surface is washed with strong soapy water, dried and oiled or painted. (1,329,573; WILLIAM H. ALLEN of Detroit, Mich.; Feb. 3, 1920.)

Stable Nitrostarch.—The carbohydrate material is subjected to a preliminary treatment whereby it is swelled or puffed in a manner resembling the puffed cereals now on the market. The porous condition permits nitration to proceed quickly and uniformly. Mixed acid containing 30 per cent HNO_3, 64 per cent H_2SO_4 and 6 per cent H_2O is used at a temperature of 40 deg. F. The carbohydrate material is kept beneath the surface of the acid by means of a perforated plate. The nitrated product is separated by removing the perforated plate and pouring water gently on the surface of the acid. The product floats on the water and is removed, washed and boiled in two successive baths of very weak acid. The product is now stabilized by boiling in a solution of a sodium soap. Further washing is followed by centrifuging and drying at 100 deg. F. (1,329,353; GEORGE R. ANCHORS of Landing, N. J.; Feb. 3, 1920.)

Manganese Dioxide Depolarizer.—Under certain conditions, the reaction between a manganous salt and sodium hypochlorite may be made to yield a deep black dioxide having good conducting properties. The hypochlorite solution is preferably added to a boiling slightly acid solution of $MnSO_4.4H_2O$ of such a concentration that the boiling point is about 103 deg. C. (1,330,738; CARLETON ELLIS and ALFRED A. WELLS of Montclair, N. J., assignors by mesne assignments to National Carbon Co.; Feb. 10, 1920.)

Recovering Sulphonic Acids From Mineral Oil Sludge.—Sludge produced in sulphonating mineral oil is dissolved in water (100 parts sludge to 150-200 parts H_2O) and allowed to stand for 8 to 12 hr. Heat is generated, SO_2 is evolved and the free oil rises to

the surface and is decanted. The solution is neutralized with lime and the precipitated calcium sulphate filtered off. The clear wine-colored solution contains the calcium sulphonate, which may be salted out by adding sufficient calcium chloride. The product is water-soluble and may be used for saponifying purposes or for the production of detergents suited for use in salt water. (1,330,624; ROBERT E. DIVINE of Cincinnati, Ohio, assignor to the Twitchell Process Co.; Feb. 10, 1920.)

Destructive Distillation of Wood.—In order to prevent "cracking" of the oils and gums formed during the destructive distillation of wood, DAVID L. HANSON of Wilmington, N. C., introduces a current of superheated steam and air into the retort and hastens the removal of the vapors by the use of a suction fan. (1,330,632; assigned to the Pine Nene Products Co.; Feb. 10, 1920.)

Plates for Electrolytic Lightning Arresters.—This invention relates to a method for the preliminary treatment of plates which are to be used in electrolytic lightning arresters, with a view to increasing the breakdown voltage. The process, as described by JOHN COULSON of Wilkinsburg, Pa., may be applied to aluminum, tantalum, platinum or magnesium, but is ordinarily used with the first of these. Aluminum plates are dipped in 1 per cent HF, then in 5 to 10 per cent HCl, and finally in 5 to 10 per cent HNO_3. The acid treatment accomplishes much more than a mere surface cleansing or etching, and appears to penetrate to a considerable distance beneath the surface of the plates. In fact, in the case of thin plates, the acid appears to entirely permeate them, and to completely remove the traces of impurities which are present. This is evident since the acid treatment entirely prevents the formation of blisters which appear when untreated plates are subjected to heat, and which result from the presence of impurities in the interior of the plates. The electrical characteristics of plates pickled in the foregoing manner are found to be materially altered, their admittance being greatly increased as well as their ability to resist high voltages. After the formation of the asymmetric conducting film the plates are preferably heat-treated at 500 to 600 deg. C. for 2 to 3 hr. This increases the breakdown voltage about 25 per cent. (1,330,581; assigned to Westinghouse Electric & Manufacturing Co.; Feb. 10, 1920.)

Manufacture of Bleaching Powder.—Chlorine and lime are passed counter-currently through a rotating horizontal cylinder provided with lugs on the interior so that the mass is mixed and prevented from sticking to the walls. The exterior of the cylinder is cooled by a stream of water in order to overcome the heat of reaction. (1,330,495; ALFRED RUDGE of Gateshead, England; Feb. 10, 1920.)

Anhydrous Metallic Chlorides.—The anhydrous chlorides of aluminum, magnesium and the cerium groups of rare earth metals may be prepared by passing a mixture of chlorine and producer gas (substantially free from hydrogen) over the heated oxide, hydroxide or oxalate of the metal in question. (1,331,257; WILLIAM HEAP of Stockport and EDGAR NEWBERG of Manchester, England; Feb. 17, 1920.)

Recovering Nitrogen Oxides.—Two methods for the recovery of nitrogen oxides from mixtures with air are described by PHILIPPE A. GUYE of Geneva, Switzerland. The gases may be cooled below —20 deg. C. and absorbed in a solvent such as CCl_4 containing C_2Cl_6 or CBr_4. Or, the oxidation of the nitric oxide may be so regulated that a mixture of N_2O_3 and NO_2 is obtained. Upon cooling the oxides below —80 deg. C., a liquid is obtained which is essentially a solution of nitrogen peroxide in nitrous anhydride. If the oxidation is carried to such an extent that only NO_2 is present, this solidifies upon cooling and tends to clog the condensing coils. (1,331,104 and 1,331,105; Feb. 17, 1920.)

Lead Plating.—With the aid of a certain flux, lead plating of iron or steel sheets or other articles may be accomplished in a manner similar to galvanizing. The flux used by ROBERT J. SHOEMAKER of Milwaukee, Wis., consists of 80 per cent zinc chloride, 15 per cent sodium chloride and 5 per cent tin chloride. By means of a frame, a considerable amount of the flux is maintained on the surface of the molten metal at the point at which the work enters. A thin layer of flux covers the rest of the bath. An alloy of 85 per cent lead, 10 per cent antimony and 5 per cent tin is recommended for the production of an adherent uniform coating, free from pinholes. (1,330,399; Feb. 10, 1920.)

Ammonium Nitrate.—The mixture of nitrogen oxides produced by the catalytic oxidation of ammonia is, as a rule, absorbed in water in the presence of oxygen to form a solution of nitric acid. For the production of ammonium nitrate, this acid solution is neutralized with ammonia, giving a dilute solution of NH_4NO_3 which must be concentrated and crystallized. Losses occur in the absorption tower, during neutralization and during evaporation. JAMES R. PARTINGTON, GEORGE J. JONES and THOMAS K. BROWNSON of London, England, have developed a direct neutralization process yielding dry ammonium nitrate. The nitrous gases are cooled to remove the excess of water formed during the catalytic oxidation:

$$4NH_3 + 5O_2 = 4NO + 6H_2O$$

and are then mixed with sufficient air or oxygen to convert the nitric oxide to nitrogen dioxide:

$$2NO + O_2 = 2NO_2$$

This gas is now mixed with ammonia, air and water vapor in the proportions indicated by the equation:

$$4NH_3 + 2H_2O + 4NO_2 + O_2 = 4NH_4NO_3$$

By careful regulation, the ammonium nitrate is obtained as a fine, dry powder which is collected by passing through chambers containing baffle plates. It is evident that nitrous gases from other sources such as the denitration of spent acid may also be used in this process. (1,330,136; Feb. 10, 1920.)

Chromium Sulphate.—The chromium sulphate used in the leather industry is usually prepared from chromate or bichromate by reducing, precipitating the hydroxide, filtering, washing and dissolving the hydroxide in sulphuric acid. FRANK M. MOONEY of Montreal, Que., claims that the following method gives a product which is free from reducing agents which have a harmful effect upon the gelatine in the hide.

$$Na_2Cr_2O_7 + H_2SO_4 = Na_2SO_4 + 2CrO_3 + H_2O \quad (1)$$

$$2CrO_3 + Na_2S_2O_3 = Na_2SO_4 + Cr_2O_3 + SO_2 \quad (2)$$

$$Cr_2O_3 + 3H_2SO_4 = Cr_2(SO_4)_3 + 3H_2O \quad (3)$$

Reaction (2) is not complete unless the solution is boiled to expel the sulphur dioxide. The precipitate of chromic oxide is washed thoroughly and then boiled with sulphuric acid to form the sulphate. (1,330,131; Feb. 10, 1920.)

Industrial Excursions of the A. C. S. St. Louis Meeting

THE entertainment committee of the St. Louis Section of the American Chemical Society more than amply provided an opportunity to get better acquainted with St. Louis for those who had come to the fifty-ninth meeting of the society. Automobile tours made it possible for the visitors to see the parks, Art Museum, Washington University and the Missouri Botanical Garden, as well as several of the chemical plants, of which we give some descriptive notes as follows:

The Laclede-Christy Clay Products Plant

On Thursday afternoon, April 15, a large party visited the plant of the Laclede-Christy Co., located in the southwestern section of St. Louis. This plant is devoted almost entirely to the production of refractories in all shapes and sizes. There are two shaft mines and one open pit mine located adjacent to the plant proper. The plant is equipped with forty periodic kilns for the burning. The total consumption in clay at this plant is 600 tons per day for refractory purposes and 100 tons for production of tile. Both wet and dry process brick is produced. Clay is crammed directly from the mine to the dry pans and thence into the dry presses and subsequently to the waste heat-drying oven. The period of drying occupies about seventy-two hours and the burning about forty-eight hours. Both cones and pyrometer control are used in regulating the kilns. The wires for pyrometer control are all run into a central dispatching station, where multiple switches permit the operator to read the temperature on each kiln.

A thoroughly equipped ceramic laboratory was installed about twenty years ago and continues in operation under the charge of experienced ceramists. Clays are analyzed and classified. Their texture and other physical characteristics are noted. Furnace gases and slags are analyzed as carefully as the clays have been and their action on the burned clays is recorded. As a result the clay mixtures have been standardized and the uniformity of finished products is thus made certain. Many special refractories are made to meet special furnace conditions.

The wet process is also used for making firebrick and sewer tile. Here the proper mixture of clay is moistened with water and passed through an extrusion press of the vertical type with the clay discharged from the side of the cylinder. It does away with the ordinary laminations so common in the pug mill.

There is also being produced in this plant a Laclede-Christy chain grate stoker for firing boilers. The present capacity on these stokers is one per day but will shortly be increased to two or three per day. The plant is a model of cleanliness and efficient operation.

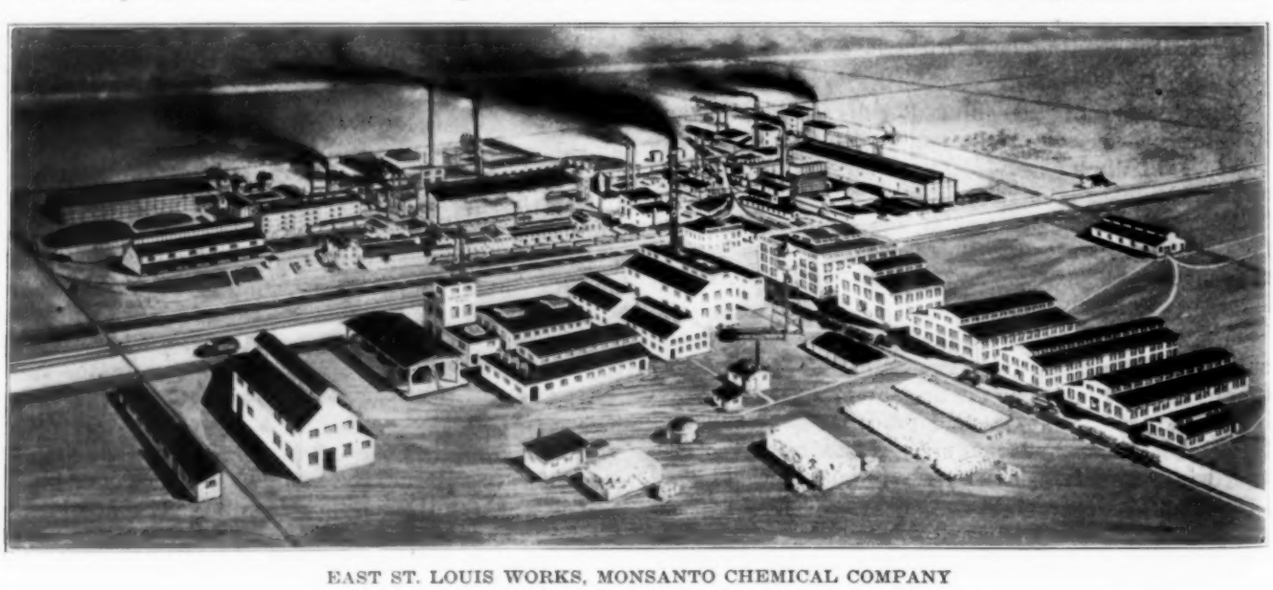
The National Lead Works

The same members who visited the Laclede-Christy Clay Products Co. were next taken to the National Lead Works, located near the former plant.

The material arrives at this plant in the form of pig lead, which is roasted in furnaces for the production of both red lead and litharge, a large bulk of which is sold to the Electric Storage Battery Co., of Philadelphia, for use in manufacturing battery plates. Located in the same building over the lead furnaces is a complete milling plant which brings the oxides to the proper consistency for both the battery and paint trade. By far the largest amount of lead, however, is used in the manufacture of white lead.

In this process the pigs are put through a stamping machine,which stamps out thin perforated circular plates of metallic lead. These, in turn, are placed in refractory pots, in the bottom of which is a quantity of 2½ per cent solution of acetic acid. The pots are porous so that the acid will percolate through the sides of the vessel in about five and one-half hours. A layer of pots is first set on the floor in a concrete bin covered with several inches of tanbark; other layers are built up until eleven tiers in all have been constructed. The whole is covered with tanbark and a pair of flues is introduced at the top for carrying off the gas. The building in which this is carried on is about 600 ft. long and 200 ft. wide, and an enormous quantity of material is fermenting continuously. This requires a large outlay of capital, as the acetic acid and lead are permitted to ferment with the tanbark over a period of 100 days.

When the fermentation process is completed, the pots are emptied into large conveyor boxes, which are carried to mills operating on the principle of the old-time millstone. The subsequent separation by screen-



EAST ST. LOUIS WORKS, MONSANTO CHEMICAL COMPANY

ILLINOIS GLASS CO., ALTON, ILL.

ing removes the white lead from the unconverted metallic lead and the former is thoroughly milled and ground in oil. The entire milling process is the most important feature of the white lead manufacture. Is is finally loaded in cans and sold under the name of Dutch white lead.

Monsanto Chemical Co.

The East St. Louis plant of the Monsanto Chemical Co. afforded more than a few hours diversion from the strenuous division meetings. The old chamber acid plant was inspected first. A testimonial for steel frame work construction could easily be obtained from a study of the operation of these chambers.

The muriatic acid retorts and tile piping and scrubbers were observed next. Perhaps the only feature found worthy of note here was the method of lining tank cars for shipments of hydrochloric acid. Ordinary saturated tar roofing felt and pitch were being used in alternate plies in somewhat the same fashion as in the construction of a specification roof.

The platinum contact oleum works next excited the curiosity of the visitors. The segment ring type of catalyzers were used with no preheating counter-current arrangements.

Some surprise arose to find a new quarter of a million dollar chamber plant almost ready for operation. The latest improvements, such as rotary sulphur burners, nitric acid weirs, etc., were included in its equipment.

Before leaving the plant, the new installation of Allen-Moore caustic soda-chlorine cells was examined. The general impression obtained from the trip was that continued expansion of the East St. Louis plant is scheduled to follow just as has been the case of its organic sister on the west side of the Mississippi.

The Standard Oil Refinery at Wood River

About 300 took advantage of the excursion to the Wood River plant of the Standard Oil Co. Friday, and subsequently to the plant of the Illinois Glass Co., at Alton, Ill.

A thorough inspection was made of all of the apparatus at the Wood River plant, which is capable of handling about 15,000 bbl. of crude oil per day. This plant produces ready for the market all the lighter distillates, petroleum, coke, paraffine wax ready for candle manufacturers, fuel oil and road oils. The company is building a new plant for the additional production of lubricating oils, as well as a large refrigerating system for use in the paraffine plant.

Very close chemical control is maintained throughout all steps of the processes and in conjunction a research laboratory is operated. One of the striking features of the plant is the fact that a large number of the stills are fired by coal. It is found cheaper to buy Illinois coal at approximately a price of $2 a ton rather than burn up the oils and distillates obtainable from the processes. The plant is equipped throughout with every precaution against fire and explosion, and the stills are so arranged that in case any of the material catches fire the combusion will be confined to a small area.

Crude oil is pumped in by pipe line from the Texas and Oklahoma fields, as well as a considerable quantity arriving by tank car. The systems of storage and tanks and stills cover about 1,500 acres of ground.

Illinois Glass Co.

On the arrival of the excursion at Alton the members were entertained at lunch by the Illinois Glass Co. and later taken over for a thorough inspection of the plant. This plant covers seventy-five acres of ground and is equipped with ten 300-ton-capacity continuous glass tanks equipped with thirty bottle-blowing machines producing 1,500,000 bottles daily, ranging in capacity from $\frac{1}{2}$ oz. to 12 gal. Three hundred and fifty tons of coal are gasified in producers and oil is consumed to an extent of 20,000 gal. daily. The daily consumption of other raw materials, including sand, lime and soda ash, is 300 tons. A complete box factory with a capacity of 10,000 boxes daily and a corrugated paper products mill with a daily production of twenty-five tons operates in conjunction with the plant.

The machinery is entirely automatic from the time the bottle-blowing machine picks up the glass batch from the revolving glass pot until the finished product is delivered to the packing room. Each automatic bottle-blowing machine consists of a base carried upon wheels supporting a central column, having six or more arms that revolve about this central axis. To each arm is attached a "blank" and blow-mold, and these are the principal features of its mechanism. As the machine revolves and each blank mold passes successively over the tank of molten glass, a valve opens and the glass is drawn into the blank mold by a vacuum process.

Each blank mold holds exactly the quantity of glass needed for making a bottle of given size, and thus the weight of every bottle is accurately measured and uniformity is secured.

After the glass is gathered into the blank mold the machine makes a quarter revolution, during which time the neck is formed. Then the blank mold opens and falls away, exposing the glass, the blow mold then rises and closes around the hot metal, air pressure is applied, and as the machine completes its revolution the glass is forced against the wall of the molds, giving the exact shape of the bottle to be produced.

In using compressed air the pressure is held steady and uniform so that the glass is evenly distributed throughout the bottle. It is this even distribution that

largely gives strength and uniform capacity to bottles made by the automatic process. The finished bottle is delivered automatically into a suitable receptacle, from which it is carried to the annealing oven, where it is tempered before being packed and shipped.

These annealing ovens are from 70 to 80 ft. in length, with floors composed of metal strips so arranged that they are drawn along slowly by large gear wheels driven by electric motor. It requires six to ten hours for a bottle to travel through the annealing oven, and the temperature at the front end, or machine end, where the bottle is first placed, is about 1,100 deg. F. The annealing oven is divided into air chambers, each cooler than the previous one, so that a bottle traveling through has its temperature gradually reduced until it reaches the rear end, where the temperature is practically the same as the outer air.

Missouri glass sands are mined by the company and shipped by rail to Alton. Even to those who have visited many manufacturing plants, the workings of the Illinois Glass Co. appeal as a marvelous mechanical achievement.

Scientific Apparatus Makers Meet

THE second annual convention of the Association of Scientific Apparatus Makers of the United States of America was held in Washington, April 22 and 23, under the chairmanship of C. S. Stoelting.

Apparatus Standardization Criticized

A special committee reported on a resolution with respect to the calibration and certification of apparatus by the National Bureau of Standards. It was emphasized that this work was of great concern, as at the present time much difficulty in getting prompt reports on apparatus tests is causing difficulties in deliveries of calibrated equipment. On request, W. D. Collins of the Bureau of Chemistry, chairman of the American Chemical Society's committee on standardized chemicals and standardized apparatus, discussed the work of his committee. He pointed out that the American Chemical Society has seriously considered establishing its own laboratory to do this calibration work, and suggested the possiblity that the Association of Apparatus Makers and the American Chemical Society might well co-operate to this end.

The very general importance of an official Government certification of calibrated apparatus was emphasized as one of the important reasons why an independent laboratory should not be established. Various means for co-operation with the Bureau of Standards were discussed, including the possibility of stationing men representing the association at the Bureau in order to expedite the work by actual assistance in it. There was evident a general desire on the part of the membership in attendance to have the testing work separated from the research work of the Bureau, in order that the testing work would not suffer through the desire of individuals or the Bureau to concentrate on research. Some such alternative placing the work upon a clean-cut business basis was favored rather than the effort to establish an independent laboratory.

Apparatus Standards Committee Report

J. M. Roberts reported for the committee on apparatus standards. Major N. E. Reasoner of the Medical Corps, U. S. Army, discussed the variety of apparatus which the Army had been compelled to procure during the war period. However, he pointed out that many points in apparatus form were of no consequence to the user except for interchangeability and therefore the user is interested primarily in standards of performance rather than the manufacturing standards under discussion. Dr. W. D. Collins also reported on the work of the American Chemical Society committee on guaranteed reagents and standardized apparatus. He pointed out that no manufacturers were represented on his committee partly because of the thought that other manufacturers might fear to give full information to the committee if a representative of their competitors were on the committee proper. However, it was pointed out that this committee of the Chemical Society would be very glad to co-operate with the committee of apparatus manufacturers.

The basis of determining the number of sizes and styles of apparatus by means of sales records was discussed at length. It was pointed out that this is a good guide in certain ways, but that so long as a multitude of sizes or styles is listed a great many of them will be ordered, although a much smaller number of varities would probably suit everyone just as well. In this connection several apparatus company representatives pointed out that in the future it was their plan to carry in stock all equipment listed in their catalogues and therefore that the number of items listed was to be very greatly reduced in the future.

In the course of this discussion several glassware manufacturers who are not dealers and therefore do not sell to users were represented. The problems which these makers of glassware meet in changing molded ware were particularly emphasized and it was urged that the problems of these persons be carefully taken into account before the Chemical Society or the apparatus makers' association committees reach final conclusions. Interchange of blue-prints or furnishing of blue-prints of each form of apparatus to the committees was suggested as the best way to undertake the work, especially that of the American Chemical Society committee.

The report of the apparatus standardization committee covering certain specifications for beakers, balances, and other apparatus was adopted by the association with the understanding it was not binding upon the membership, but with the recommendation that all members changing their catalogues during the coming year be guided by its recommendations.

Pyrometer Section

The session of the pyrometer section of the Association dealt principally with the matter of pyrometer materials. Considerable progress was reported, but no definite recommendations were reached at these sessions.

College of City of New York to Give Engineering Degrees

The Board of Trustees of the College of the City of New York has authorized the granting of degrees of Chemical, Civil, Electrical, and Mechanical Engineer on the satisfactory completion of a curriculum requiring five years. The announcement of the details of the curricula will shortly be issued. This is one of the steps taken by the College of the City of New York in the direction of closer co-operation between industry and colleges and universities.

Current Events
in the Chemical and Metallurgical Industries

Engineering Conference

The governing boards of four founder engineering societies met in Chicago April 19 and 20 under the auspices of the Western Society of Engineers. These four societies are the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

On Monday evening there was a joint engineering society dinner at the La Salle Hotel. At this dinner A. Stuart Baldwin, past president of the Western Society of Engineers, was toastmaster. Speakers were Arthur C. Davis, president of the American Society of Civil Engineers; Arthur Fletcher, representing the American Institute of Mining and Metallurgical Engineers; Fred J. Miller, president of the American Society of Mechanical Engineers, and Calvert Townley, president of the Electrical Engineers.

The purpose of this meeting was to form plans for better co-operation between the national societies in giving service to the public and securing proper publicity for the professions in general. The Western Society of Engineers presented plans as to how this may be brought about in Chicago, and they are now being considered by the various societies.

The Chicago Chemists' Club

The first get-together meeting of the Chicago Chemists' Club was held as an informal dinner in the quarters at the City Club building on the evening of April 21 with about sixty members in attendance. W. Lee Lewis of Northwestern University delivered a talk on gas warfare redolent with the fumes of butyl mercaptan and other interesting odors. He called attention to the early history of conflict by the use of poisons, commencing with the snake, skunk, et cetera, in animal life and continuing through the savage races to the more recent inauguration into modern warfare by the Germans. Statistics were presented to the effect that only 2 per cent of the casualties die in gas attacks while 24 per cent are lost under shell fire. Gas warfare is most humane and at the same time most effective. This in spite of the propaganda put forth in the United States and England when the Germans first employed chlorine against the Canadians. The talk was concluded by a plea for the maintenance of our activities in the development of new gases and a protest against the retirement of General Sibert to an inactive position in the Army.

Chicago Section, American Ceramic Society

The Chicago Section of the American Ceramic Society met with the Illinois Clay Manufacturers' Association at the Hotel LaSalle, Chicago, on April 20 and 21. The chief event of the occasion was an informal dinner on Tuesday evening with H. T. Bellamy, chairman of the Chicago Section, presiding. H. P. Matzen, of the Carrier Engineering Corporation, presented a paper on "Humidity Drying." I. E. Hardy made a plea for more scientific methods in the enamel brick industry, and informal addresses were given by other members of the two associations.

During the meetings on Tuesday afternoon the forced draft system of burning was informally discussed, and Prof. E. W. Washburn, of Illinois University, delivered an address on "Some of the Factors Involved in the Drying of Clay Wares." "The Tunnel Kiln" was presented by Conrad Dressler and Prof. Carl B. Harrop; C. W. Parmelee of University of Illinois offered a paper on "The Composition of a Paving Brick as Related to Its Rattler Test." The sentiment of the various members during all the discussion called for a greater application of science to the problems of the brick industry, and many members spoke in high appreciation of the work being done by the various universities along these lines.

American Foundrymen's Association to Have New Department

At the annual meeting of the American Foundrymen's Association to be held in Columbus, Ohio, Oct. 4 to 8, a new department will be added to the program to be known as the non-ferrous casting section. At the meetings of this section, papers and discussions of interest to the practical brass and aluminum foundrymen will be presented.

It is understood that the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers will hold a meeting in Columbus during the same week and it is proposed to have a joint session of the non-ferrous section of the American Foundrymen's Association and the Institute of Metals Division of the A.I.M.E.

The other sections that will be represented on the program of the American Foundrymen's Association are the gray iron section, the steel foundry section, the malleable iron section, and the industrial relations section, and in conjunction with these meetings will be held the usual exhibit of foundry and machine shop tools, equipment and supplies.

Meeting of Northern Ohio Section American Ceramic Society

The Northern Ohio Section of the American Ceramic Society met recently in Detroit under the direction of Dr. A. F. Gorton, chairman, and Charles H. Stone, Jr., secretary. Twenty-seven members in all attended this meeting.

The various plants in the vicinity of Detroit were visited, including the Jeffery-DeWitt Co., manufacturer of porcelains for the Champion Spark Plug Co., of Toledo, the Detroit Star Grinding Wheel Co., the Ford Motor Co., and the Pewabic Pottery Co. Luncheon was served at the Detroit Athletic Club and in the evening an informal dinner was enjoyed.

Data From Washburn's Testimony

In the course of his recent testimony before the Senate Committee on Agriculture, Frank S. Washburn presented some interesting data on the consumption of nitrate and ammonia nitrogen and on the estimated future production of ammonium sulphate. These figures are given in Tables I, II and III.

TABLE I. DEMAND FOR NITRATE NITROGEN IN UNITED STATES, 1914[1]

	Per Cent
Sodium nitrate used by fertilizer manufacturers	28
Sodium nitrate used by farmers (bought unmixed)	17
Nitric oxide used in manufacture of sulphuric acid	7
Nitric oxide used in fortifying mixed acid	17
Mixed acid for nitration	12
Oxidizing agent in glass manufacture	6
Oxidizing agent in explosives (as $NaNO_3$)	8
C. p. chemicals for miscellaneous chemical uses	5
	100

[1]Total demand equivalent to 540,000 tons $NaNO_3$.

TABLE II. CONSUMPTION OF AMMONIA COMPOUNDS IN UNITED STATES, 1914[1]

	Per Cent
Ammonium sulphate used in mixed fertilizer	55
Anhydrous ammonia for refrigeration	12
Aqua ammonia for refrigeration, soda ash, explosives, etc.	33
	100

[1]Total demand equivalent to 270,000 tons $(NH_4)_2SO_4$.

TABLE III. AMMONIUM SULPHATE PRODUCTION

	Capacity of Byproduct Ovens		Surplus over Anticipated Demands	
	Nitrogen Tons	Ammonium Sulphate Tons	Nitrogen Tons	Ammonium Sulphate Tons
1918	95,000	455,000	20,000	100,000
1919	90,000	450,000	10,000	50,000
1920	111,000	555,000	25,000	125,000
1925	142,000*a*	710,000		
1930	170,000*a*	850,000		
	204,000*b*	1,020,000		
	239,000*c*	1,195,000		

a.—Assuming normal increase in pig iron production and that coke required will come from new byproduct ovens.
b.—Assuming one-half of existing beehive ovens to be replaced by byproduct ovens.
c.—Assuming all existing beehive ovens to be replaced by byproduct ovens.

With regard to the cost of water power at Muscle Shoals, Mr. Washburn said:

"They are proposing now to spend $25,000,000 for a 100,000-hp. plant. That is $250 per hp. Let us assume you could use all of it throughout the year and have no losses from idle time. Five per cent on the cost of your power, nothing else, is $12.50 a horsepower year. Yet these gentlemen in making their estimates have referred to $1.69 for power in one case and in another case about three times that amount. It is true that they did not intend to cover the interest when they mentioned those amounts, but to talk about a cost of $1.69 per horsepower year is so misleading that the mind gets to operating on the basis of $1.69 and forgets that the interest alone that this Government has to pay out, in this period of the highest taxation it has ever known, will be $12.50 a year per hp. My estimate of the cost of producing hydroelectric power at Muscle Shoals is as follows:

Administration and labor		$100,000
Maintenance and supply		60,000
Depreciation, obsolescence, insurance and extraordinary repairs:		
Power house, dam and lock		408,900
Equipment		251,500
Contingencies		60,000
Interest, 5 per cent		1,250,000
Steam plant standby:		
Maintenance	$25,000	
Supplies	15,000	
Heat and light	7,500	
		47,500
Entire total		$2,177,900
Cost per kw.-year		$29.00
Cost per hp.-year		21.77
Cost per kw.-hr.		.0033

"The cost is not only prohibitive but here is the crime in that thing:

"About 90 per cent of the cost of that water power is interest and other percentage items that depend upon cost.

"The Government's position is not only to build the Muscle Shoals hydro-electric plant at a time when taxes are the highest and put $25,000,000 into that item alone, but they propose to do it when labor and materials are the highest this country ever has known. That is not the worst of it. They already have a power plant and they will produce the power and produce it at Government expense at no greater cost than their waterpower after they get it."

"Ten Commandments" for Trade

The Canadian Reconstruction Association, which has long been actively associated with the "Made in Canada" campaign, has formulated the following "Ten Commandments for Canadian Trade":

1. *Buy Canadian products.* In doing so you develop the home market, encourage factory expansion, provide employment for new populations, and create bigger and better markets for all kinds of farm produce. New factories, expansion of old factories, greater production, more workers, and better agricultural market mean national progress.

2. *Import only necessities,* and then only if similar Canadian articles or substitutes are not available. With Canadian money at a discount of 10 to 15 per cent, exchange with the United States is costing Canadian consumers between $75,000,000 and $100,000,000 a year.

3. *Produce to the limit in field and factory.* Increased production means new wealth and is essential to the success of any effort to reduce imports and promote export trade.

4. *Co-operate, conserve, specialize, standardize.* These are the means to maximum production of high-quality goods at minimum cost.

5. *Develop export markets.* Foreign business gives stability to trade. It reduces unit costs, benefits domestic consumer, affords employment to factories and workers in times of depression, and corrects adverse exchange by improving the trade balance.

6. *Utilize Canadian services.* Ship by Canadian carriers through Canadian ports. Patronize Canadian railways, Canadian steamships, and Canadian banks. Place insurance in Canadian companies. Employ Canadian architects, engineers, scientists, and other experts. Spend vacations in Canada.

7. *Manufacture raw materials to final stages in Canada.* Hundreds of millions of dollars are lost annually to the Dominion, and especially to Canadian wage earners, by the exportation of raw materials and semi-manufactured products.

8. *Use science for the determination and development of natural resources.* Industrial research will reveal new wealth, improve industrial processes, and help to relieve our economic dependence upon outside sources for fuel, iron, and other essentials.

9. *Make quality the hall mark of Canadian products.* In return for public support of the home market Canadian manufacturers should provide products that compare favorably with imported goods and Canadian workers should recognize good workmanship and maximum production as their standards.

10. *Be fair to capital.* Canadian money should be encouraged to invest at home and foreign capital attracted to promote Canadian industrial expansion.

Langmuir's New Conceptions

Dr. Irving Langmuir in his address before the National Academy of Sciences at Washington, Tuesday evening, April 27, presented an entirely new theory on the structure of matter. Explaining that his conclusions led to a new conception of energy, force, time, space, magnetism and all the general properties of matter, Dr. Langmuir asserted that "space and time have a structure analogous to that of matter."

Heretofore, the speaker said, the usual conception of the relative order of the components of matter has been atoms, electrons, molecules and particles. His observations add a new division, smaller even than the atom, which he has named the "quantel."

It consists of two parts, he said, positive and negative, present everywhere in space, moving in all directions with the velocity of light and capable of passing through matter. They constitute what has heretofore been known as the "ether of space" and cause all of the phenomena of light, electricity, mass and energy.

"The structure of everything that is" can be built up out of his conception of the quantel, Dr. Langmuir said. The theory explains all of the mysterious relationships heretofore known to exist between spectral lines, he asserted, predicting that it would lead to the discovery of many new relationships.

Chandler Medal Presented to Willis Rodney Whitney

On Tuesday evening, April 27, Dr. Willis R. Whitney gave an address entitled "The Littlest Things of Chemistry" to an attentive and eager audience, all of whom had braved an unusually cold April shower and many of whom drew "standing room only" tickets, that they might see the first presentation of the Chandler Medal since the entrance of the United States into the World War. Could Dr. Whitney have guessed that his associate, Dr. Langmuir, was going to launch quantels down in Washington one hour before his own address, he would probably have not used either the superlative, comparative or picturesque and just called his address: "Some Real Dope on Electrons." The interpretation of the theory that has been built up around this conception of matter affords more than a fascinating pastime. Dr. Whitney justified his belief in the electron theory of matter by showing that he actually makes use of it in his research. The argon rectifier and many other electrical devices are based on phenomena that can only be understood on the electron basis. No attempt will be made to give the details of the address, as it does not lend itself well to abstraction and will be published in full in the June issue of the *Journal of Industrial and Engineering Chemistry.*

Address

After stating that he had never heard so many ideas on chemistry expressed in a single hour, Dr. Chandler presented the medal with the following remarks:

"It is my privilege to present to Dr. Willis Rodney Whitney the Chandler Medal. I appear as the representative of the more than 500 of my old pupils and other friends who in 1910 established this foundation in honor of their old professor. One of these founders graduated as early as 1847, and several others during the succeeding years prior to 1864, when I began with Profs. Egleston and Vinton to teach in the newly founded School of Mines.

"I was deeply gratified when I learned from Prof. McKee that the distinguished Dr. Whitney had consented to deliver the annual lecture. The name is dear to me, and suggests a possible blood relationship between us. My mother was a Miss Whitney of Boston.

Academic Record

"Dr. Whitney was born at Jamestown, N. Y., on Aug. 22, 1868. He graduated at the Massachusetts Institute of Technology in 1890, receiving the degree of S.B. In 1896 he received the degree of Ph.D. at Leipzig. He has been most successful as a teacher of chemistry, having filled the following positions at the Institute of Technology:

1890-1892—Assistant instructor in sanitary chemistry.
1892-1894—Instructor in sanitary chemistry.
1898-1901—Instructor in theoretical chemistry and proximate analysis.
1901-1904—Assistant professor in theoretical chemistry.
1904-1908—Non-resident associate professor of theoretical chemistry.
1908—Non-resident professor of chemical research.

Research Experience

"Since 1900 Dr. Whitney has been the director of the research laboratory of the General Electric Co. at Schenectady, and recently during the war has been a member of the Naval Consulting Board and director of research work at Washington. Words and time fail me to give you any adequate idea of the number, variety and importance of the researches which have been successfully conducted by him and his willing assistants and associates during the past twenty years. Some idea of the magnitude of his activities can be realized from the fact that he has developed the research laboratory at Schenectady from its inception till now he has the direction of more than 150 persons working with him.

"It would require a series of lectures to lay before you an adequate account of the various important results which have been developed under Dr. Whitney's direction. The first radical improvement in the carbon incandescent filament since Edison first produced it was due to Dr. Whitney's personal work. The 'Gem' lamp which he developed with its 'metallized' filament, embodying a new form of carbon, gave 25 per cent more light with the same wattage than the standard carbon filament lamp. Still greater improvements resulted in his laboratory when the drawn wire of tungten gave us the 'tungsten lamp,' then the gas-filled half-watt lamp. Then in arc lighting the laboratory developed the magnetic electrodes, and produced the most successful arc lamp of today.

"Did time warrant, I would gladly tell you about numerous other wonderful discoveries and inventions in the practise of the industrial arts which Dr. Whitney suggested and inspired in his twenty years of research work, and also remind you of the numerous scientific papers he has published in the journals.

The Presentation

"Now, Dr. Whitney, permit me to present to you, as representative of the president and trustees of Columbia University and the more than 500 alumni and friends who established this foundation in 1910, the Chandler Medal, in recognition of your wonderful and successful labors in the application of physics and chemistry to the industries of this country."

New International Chamber of Commerce

The new International Chamber of Commerce, projected at the International Trade Conference at Atlantic City last October, will be formally organized, it is announced by the Chamber of Commerce of the United States, at Paris during the week of June 21. Invitations have been sent out by the American group of the International Organization Committee to business and industrial associations, asking them to name delegates to participate in the organization meeting. About one hundred delegates from the United States are expected to attend.

The International Organization Committee, which was provided for at the International Trade Conference, is to meet at Paris in advance of the general organization meeting, which will be held in June, to prepare and report a plan of permanent organization, the basis of which was drafted and approved at the International Trade Conference. Plans will be presented by the organization committee for a strong and active international chamber. Steps will be taken for the creation of a permanent international headquarters; officers will be elected, and the work of the chamber will actually be started.

The International Chamber succeeds the old International Congress of Chambers of Commerce, which ceased to function with the outbreak of the World War in 1914.

Aims of the Organization

The specific aims of the organization as outlined by the committee on organization are:

To create a permanent international headquarters to centralize all data concerning economic subjects and social conditions, the facts relating to the respective needs, present production, and future possibilities of each country; to act as an instrument of co-ordination which will suggest trade regulations and legislative measures to facilitate and encourage the development of economic commerce; to inform public opinion, through the publication of facts, with regard to business conditions, and through the dissemination of views of technical experts and business men; to put at the disposal of all official organizations the reports and conclusions prepared by these experts and business men.

Constitution of the Chamber

The committee on permanent organization of the International Trade Conference agreed tentatively that the constitution of the new chamber should provide, among other things, for: A board of directors composed of two members selected by each nation; an international headquarters, with one representative of each nation attached to it, assisted by technical experts, all to be under direction of a general secretary; a corresponding bureau in each country; membership to consist of chambers of commerce, commercial organizations, banking and similar associations, firms, corporations and individuals holding associate but not voting membership; meetings of the membership every two years; a system of referenda to be issued during the interval between the biennial meetings of the members.

Other Objects of the Association

Other objects of the association are: To make import and export trade easier; to remove international friction, much of which begins with commercial differences; to safeguard international trade against waste and fraud; to increase the total production of the world, and make the product available to the people of the world; to standardize international documents, practices, and laws affecting commercial intercourse; to increase mutual profitableness of international transactions; to cultivate personal acquaintanceship among business men and bankers of the different nations of the world, and in this manner lessen international prejudices and misunderstandings.

At the first meeting in June only the five countries participating in the International Trade Conference—the United States, Belgium, Great Britain, France, and Italy—will be represented. Later, business organizations in the other principal countries of the world will be taken into membership.

The Short Course in Ceramics at Illinois University

The two weeks' course in clay working recently closed at the State University, Champaign, Ill., was attended by thirty-five students, ranging from the younger men of the industry to prominent executives of the corporations. Work had been carefully planned by the faculty so that an extremely large mass of detail was presented in the short time allowed. In addition to Dr. E. W. Washburn's immediate staff, other members of the university organization who are specialists in lines relating to the clay business assisted with the instruction. E. W. Tillotson, of the Mellon Institute at Pittsburgh, conducted a course in glass manufacture. A. V. Bleininger, U. S. Bureau of Standards, Washington, D. C., lectured on refractories and burning operations.

This effort on the part of an enthusiastic educational organization makes for definite progress in bringing even the most humble clay worker to a realization of the opportunity for increased profits through the adaptation of scientific methods in manufacture of clay wares. The methods of procedure as outlined for use in studying the work in any particular case were so simple that the non-scientific producer would find them easily adaptable.

Aside from the many data carried away by the students there was an added inspiration to higher things for the ceramic art instilled by the earnest lecturers of the course. One student had attended the school for three successive times simply for the enthusiastic impulse he received for the work of the months following.

The faculty gave a smoker at the Beta Theta Pi house for the students of the short course, with invitations to the upper classmen of the regular ceramic engineering courses. Speeches of warm appreciation for the work done by the faculty were made by those in attendance.

Electrochemical Colloquium

The Electrochemical Colloquium for research men in New York and vicinity is being held at 7.45 p.m. on the second and fourth Mondays of each month, in Room 301, Mines Building, Columbia University. A theoretical paper and an industrial paper are reviewed and discussed each time. The Colloquium is a democratic effort by men of varying grades of distinction to keep abreast of the important electrochemical researches of the present day, both in the United States and abroad. All who are interested are invited to participate.

The Vocational School of the C. W. S.

Throughout the U. S. Army training schools for recruits have been organized in fulfillment of the slogan "Enlist and learn!" The Edgewood Arsenal has become headquarters for the Chemical Warfare Service, and here are gathered the recruits, of whom about 1,250 have enlisted since the beginning of the year. These are raw recruits and they have the option to enter the vocational school or not, and the choice of subjects offered for study. This extra training consists in three hours' daily school work five days a week for eleven months a year. Dr. Allen Rogers of Pratt Institute, Brooklyn, is the educational director with rank of "consulting expert" in connection with the War Plans Division operating under a special appropriation by Congress. Other teachers are in the Civil Service. The courses already established are, 1, Electricity; 2, Automobile Mechanics; 3, Machine Shop Practice; 4, Printing; 5, Commercial Course; 6, Grade Work (for illiterates and those who have not completed a grammar school course), and 7, Chemistry.

The vocational training schools have proved a veritable life-saver for the Army, in that the young men of from twenty to twenty-five years of age who enlist are generally a fine lot of fellows. They are ambitious and want to prepare themselves for a good career. Present enlistments in the C. W. S. are for only one year, but it is hoped that this will soon be changed to a three years' term, and thus give the authorities a chance to provide strong courses.

The old barracks are now used for classrooms, and mess halls have been fitted over for shops. One wing is used for automobile mechanics, another for electricity, still another for machine shops, and another for the chemical laboratory. Teachers live in the old Fourth Battalion Headquarters.

About 600 of the 1,250 recruits are taking vocational courses at the present time.

The Courses Provided

The courses in detail are:

Electrical Department. Recruits are taught wiring, etc., together with enough of the principles of electricity to make them journeyman electricians.

Automobile Mechanics. The first rush was for this course because it was thought to be a chauffeur school, and that it would provide opportunities for joy rides. Later on the less thoughtful applicants dropped out. The men are taught assembling and repair work, with driving as a later accomplishment. The shops are but partly equipped with six or eight cars at present, but about thirty cars in all are expected.

Machine Shop Practice. This includes bench work, lathe and general tool work to fit them to be machinists.

Printing. A regular apprentice course.

Commercial Course. Includes accounting, stenography, typewriting and general business.

Grade Work. This provides for illiterates who are learning to read and write. It teaches English to the few foreigners (mostly Italians) who do not speak the language, and it provides a course in citizenship.

Chemistry. This trains men to work as laboratory assistants and to engage in chemical factory work.

The Chemical Warfare Service needs men not only trained to throw bombs, but also those who can repair and drive trucks, electricians for the electrical equipment, men competent as mechanics for machine shop work, men to help in the laboratories, clerks in the offices and printers for the confidential circulars which in practice are frequently distributed. Later on carpentry and plumbing will be added.

There are now over 100 vocational schools in the Army, counting this of the C. W. S. as one. During the coming summer it is planned to organize a month's camp for teachers only, for conference and for the purpose of improving the system of the educational work.

Personal

Major Earl J. Atkinson has been assigned to the command of Edgewood Arsenal. Major Atkinson organized and commanded the first gas regiment in France. He has been serving as engineer instructor at Camp Benning.

M. W. Bray and J. A. Staidl have recently joined the staff of the Forest Products Laboratory. Their work will consist in a study of analytical methods for wood and wood pulp.

Dr. F. G. Cottrell, chief metallurgist of the U. S. Bureau of Mines, will be the recipient of the Willard Gibbs Medal for this year at the May meeting of the Chicago Section of the American Chemical Society, May 21, 1920.

Spencer A. Colville, formerly with the New Amsterdam Gas Co., has been appointed as associate gas engineer of the Bureau of Standards. The Bureau of Standards and the American Gas Association have completed arrangements and secured the aproval of the American Engineering Standards Committee, to be joint sponsors in preparation of the proposed national gas safety code which was partially developed by the Bureau of Standards several years ago, but laid aside because of war work of the bureau. He will assist in these investigations, under the direction of Dr. E. B. Rosa, chief physicist of the bureau, and W. M. Berry, in charge of the Gas Engineering Section.

Prof. C. H. Desch, who has been appointed to the chair of metallurgy in the University of Sheffield (England), was presented by the instructors and students of the evening classes of the Royal Technical College, Glasgow, with a suit case, to mark his departure from the college.

Assistant Professor J. W. E. Glattfeld returned to the University of Chicago on April 1. For three months he has been making researches at the Desert Laboratory of the Carnegie Institution, Tucson, Ariz.

E. J. Mehren, editor of *Engineering News-Record*, has sailed for Europe to study conditions in England, France and Germany and will be abroad until the latter part of August.

H. F. J. Porter will give an illustrated lecture at the Engineers' Club, New York City, May 5. His topics will be "Cornelius Henry Delamater, the Business Man" and "Captain John Ericsson, the Engineer."

Carleton W. Reade, formerly chief chemist for the Delta Chemical Co., Wells, Mich., is now chemist for the Marinette & Menominee Paper Co., Marinette, Wis.

William Kent Shepard, assistant professor of mechanical engineering, Mason Laboratory, Yale University, will take a position about the middle of June with The Barrett Co. at Edgewater, N. J., as head of the division of engineering research.

C. G. Stupp is now assistant chief chemist of the research department of The Barrett Co. at Edgewater, N. J.

The officers of the Association of Scientific Apparatus Makers elected for the coming year were as follows: President, M. E. Leeds; vice-president, H. N. Ott; secretary-treasurer, J. M. Roberts; members of the board of directors, C. M. Stoelting, Mr. Evans, Walter Eimer and L. G. Wilson.

Obituary

GEORGE W. KETTER, who was in charge of electrical installations for the Electric Furnace Construction Co., Philadelphia, died at Claremont, N. H., on April 22, after a short attack of pneumonia.

ELI HILLES LARKIN died at St. Louis, April 16, 1920, in his eighty-first year. Mr. Larkin received his early education in the schools of St. Louis and completed his professional education as a chemist in Germany. With the late Henry V. Scheffer, he founded the co-partnership of Larkin & Scheffer, manufacturing chemists, which later became the Larkin & Scheffer Chemical Co., a corporation, and continued in business in St. Louis until 1911. The firm of Larkin & Scheffer originated the commercial manufacture of liquid anhydrous ammonia in 1879. Mr. Larkin designed the first anhydrous ammonia shipping cylinder, which, improved and perfected, has made possible the operation of isolated ammonia type ice-making and refrigerating plants throughout the world. In 1890 the ammonia business of the Larkin & Scheffer Chemical Co. was acquired by the National Ammonia Co., and until his death Mr. Larkin was a director of that company and technical superintendent of its St. Louis factory. Mr. Larkin was a bachelor, a studious devotee of the science of chemistry and a successful developer of methods for the commercial manufacture of many chemical products. His conspicuous characteristics were a quiet modesty and generous practical charity and philanthropy. His practice was to discover worthy objects of charity and deserving philanthropy and promptly and directly to relieve the one and aid the other. His numerous benefactions were as a rule anonymously bestowed. In his will he bequeathed about $200,000 to various religious and charitable institutions, and in addition he provided liberally for the David Ranken, Jr., School of Mechanical Trades. The "Larkin Foundation," established in the Ranken School of Mechanical Trades, provides for instruction in power plant operation, refrigerating, heating, for lecture courses in technical subjects, and for financial assistance to desirable students.

OLIVER SHEPPARD PICHER, president of the Eagle-Picher Lead Co., died after a short illness of pneumonia, at his home in Winnetka, Ill., on Monday, April 26. Few, even of his business associates, knew of his illness, and his death came to all as a terrific shock. He was a man of unusual vigor, great ability and an exceptionally winning personality, and had built up an organization characterized by a spirit of marked unity of purpose and personal loyalty on the part of each individual, so that every man in the company feels his death as a personal loss. He was an accountant, a metallurgist, a mining engineer, a chemist, a manufacturer and a financier. He was born at Springfield, Mo., but spent his boyhood and youth in California. He was a graduate of Leland Stanford University and Columbia Law School. After finishing his law course he spent three years in the office of the Hon. Elihu Root of New York. Later he went to Joplin, Mo., where his father, Judge O. H. Picher, was president of the Picher Lead Co., with the intention of practicing law there, but soon became interested in manufacturing and abandoned the law for business. In 1906 he became secretary of the Picher Lead Co., a position which he held for three years, until he was elected president to succeed his father, who had retired and gone to live in California. In 1916 the Eagle White Lead Co. and the Picher Lead Co. were merged into the Eagle-Picher Lead Co., and Mr. Picher became president of the consolidated companies, a position which he filled with great brilliancy and success until his death. In 1904 he married Emily Stanton, and had four children, two sons and two daughters, all living. He was director and chairman of the finance committee of the American Zinc Institute. He was a member of the Society of Colonial Wars, Sons of the Revolution, and Columbia Chapter of Alpha Delta Phi.

Current Market Reports

The Non-Ferrous Metal Market

New York, May 3, 1920.—The copper market is strengthening and better business is expected next week. The lead and zinc markets are dull, and prices have declined slightly since last week. Tin is holding its own, 61¼c. being quoted up to April-May, 61c. up to June-July. The freight congestion keeps the market quiet.

	Cents per Lb.
Copper, electrolytic	18.50
Aluminum, 98 to 99 per cent.	32@33
Antimony, wholesale lots	10.00@10.50
Nickel, ordinary	43.00
Nickel, electrolytic	45.00
Tin, Straits, spot	61.00
Lead, New York, spot	8.87½
Lead, E. St. Louis, spot	8.50
Zinc, spot, New York	8.50
Zinc, spot, E. St. Louis	7.95

OTHER METALS

Silver	oz.	$1.14
Cadmium	lb.	1.40@1.50
Bismuth, (500 lb. lots)	lb.	2.50
Cobalt	lb.	1.50
Magnesium (f.o.b. Niagara Falls)	lb.	1.60
Platinum	oz.	142.00
Iridium	oz.	250.00
Palladium	oz.	142.00
Mercury	75 lb.	100.00

FINISHED METAL PRODUCTS	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	29.50
Copper sheets, cold rolled, (over 14 oz.)	31.50
Copper bottoms	38.00
Copper rods	23.00
High brass wire and sheets	25.25
High brass rods	23.75
Low brass wire and sheets	27.25
Low brass rods	28.00
Brazed brass tubing	37.00
Brazed bronze tubing	41.75
Seamless copper tubing	34.50
Seamless high brass tubing	30.50

SCRAP METALS	Cents per Lb. Buying Price
Aluminum, cast scrap	21.75@22.75
Aluminum, sheet scrap	21.25@22.50
Copper, heavy machinery comp	13.50@14.00
Copper, heavy and wire	13.50@13.75
Copper, light and bottoms	12.25@12.75
Copper, heavy cut and crucible	14.75@15.00
Brass, heavy	7.50@ 8.00
Brass, light	7.00@ 7.50
No. 1 clean brass turnings	8.25@ 8.50
No. 1 comp. turnings	10.25@10.75
Lead, tea	5.25@ 5.40
Lead, heavy	7.00@ 7.25
Zinc, scrap	4.25@ 4.50

The Iron and Steel Market

Pittsburgh, Pa., April 30, 1920.

Transportation conditions, as affected by the rail strike, may have improved materially, but the iron and steel industry itself feels little improvement. On the whole the industry is as much hampered as it has been at any time since the strike started about three weeks ago. While there is some increase in the movement of material, that is largely if not wholly offset by the exhaustion of stocks, particularly of coke at blast furnaces, and by the accumulation of finished products at steel mills.

The Southern and Eastern Districts are scarcely affected, but the iron and steel industry of the Central West has its main arteries of communication, both between parts of the industry and with customers, almost completely clogged. The movement of Connellsville coke has been about one-half the normal, and the movement that occurs is chiefly in solid trainloads, which can be got through only to certain points, chiefly to the lower Monongahela valley, while a few trainloads have gone to the Mahoning and Shenango valleys. There is fairly complete communication with Buffalo. As to the byproduct coke plants, those at Cleveland are doing poorly, while the Lorain plant is running almost full, the Youngstown plants are practically idle and the Benwood, W. Va., plant is operating.

Considering the iron and steel industry as a whole, production of pig iron and finished steel is in the neighborhood of 80 per cent of normal, while shipments of finished steel are hardly much more than 60 per cent of normal.

The iron and steel markets are extremely apathetic. There is a large collection of discouraging factors—discouraging alike to buyers and sellers. Money conditions are, of course, altogether unsatisfactory, with loans for commercial purposes difficult to obtain and with investors generally unwilling to engage in new projects. The outlook as to the willingness of labor to function has been growing poorer again. Strikes are threatened in various cities of machinists, molders and members of other crafts, and even the iron and steel industry itself is again the seat of considerable unrest.

Steel prices in general remain as formerly, the policy of nearly all the independents being to hold to their various prices, which represent premiums for delivery, it being the delivery that varies rather than the price.

Occasional exceptions to this general principle are now noticed, in that in a few special cases in the past week large independent mills have sold merchant bars and structural shapes at the Steel Corporation or Industrial Board prices, 2.35c. for bars and 2.45c. for shapes. The same mills, however, continue to quote their former prices on ordinary business, 2.90c. to 3c. on bars and 3c. to 3.10c. on shapes.

Pig Iron

It is not clearly established whether the production or the consumption of merchant pig iron is curtailed the more by the rail strike, but if the curtailment in production was the greater early in the strike it is likely that with the strike's prolongation the curtailment in consumption will prove the greater. This trend arises from the fact that coke is being got through in solid trainloads to merchant furnaces in some instances, while the distribution of pig iron is very difficult and foundries are running out of stocks, either of pig iron or of coke. Pig iron stocks in consumers' hands are not large, as deliveries of late have been chiefly of iron bought after the pig iron advance was well under way. There is no weakness apparent in pig iron prices, however, but rather the reverse. A technical advance over the market of a few weeks ago is recorded, in that the only quotable market now is the prompt market, there being no interest whatever in second half, while until recently the second half market was the chief part of the market. At that time the valley market stood at $42 for bessemer, $41.50 for basic and $42 for foundry, but now, on the basis of recent sales for early deliveries the quotable market is: bessemer, $42.50; basic, $43; foundry, $43, f.o.b. valley furnaces, freight to Pittsburgh being $1.40.

Chemical and Allied Industrial Markets

New York, April 30, 1920.

The transportation situation is the direct cause of the present depression in these markets. Prices are exceptionally high, but there is very little business being transacted, on account of there being no available material. Originally the car shortage was the stumbling block and the present nominally lifted freight embargo has practically exhausted spot supplies. Producers are unable to obtain the crude material and have been forced to curtail their production to such an extent that it will be some time before they will be in a position to consider new contracts. Shipment by truck has been attempted in some cases, but for long hauls has failed, as the cost is prohibitive. Quotations as received are invariably prices at the works with no mention of shipment made.

General Chemicals

Acetic anhydride came up from 60@65c. per lb. of last week to 65@75c., with slightly better than the usual business manifested, while *acetic acid*, due to extreme shortage, is listed at $3.50@$4.50 per cwt. for 28 per cent, $6.50@$8 for 56 per cent, and $15.50@$17.50 for 99½ per cent glacial, with the latter figure in all cases the most common. Quotations on *aluminum sulphate*, commercial, are nominal, as there is practically no material to be had. Small sales are reported at 2@3c. per lb., and as high as 3@4c. is being asked for *iron-free* grade. Under the pressure of increasing demand and dwindling supplies, *chloroform* came up from 29@32c. per lb. of last week to 32@38c., this situation also applying to *iodine*, resublimed, previously listed at $4.10@$4.30, but now quoted 35@40c. higher. Producers are unable to meet the demand on *magnesium sulphate*, and a considerable shortage of spot material has placed this item in practically a nominal position, current quotations ranging from $3.50@$4.25 per cwt. for U.S.P. and $3.25@$3.60 on commercial.

The extreme shortage of *bleaching powder* and both grades of *soda ash* has held these materials firm at previous levels; inquiry both foreign and domestic continues very heavy, but little actual business has been reported. *Sulphuric acid* remained firm, with very little material coming into the market. It is reported that even with better transportation facilities manufacturers would not be able to cope with the present heavy demand; 60 deg., tank cars, is quoted at $14@$18, 66 deg. at $22@$35 per ton, depending upon the quantity. No change has occurred in *barium* products; chloride remains nominally quoted at $150@$175 per ton, while nitrate holds firm at 10@12c. per lb.

Coal-Tar Products

Buyers of coal-tar products are not inquiring as heavily as before, probably realizing the crisis this market is facing. Plants are being forced to shut down owing to the lack of raw supplies and the inability to ship whatever material is being turned out. Trucking has been resorted to rather extensively but at a very heavy cost and it is the opinion of many that if conditions do not become easier very soon many of the plants will have to shut down completely.

Naphthalene is the latest to join "the nominally-to-be-had-items-at-this-price," 15c. per lb. being asked for both flake and balls, but they can be obtained at this price only in small quantity with no guaranty regarding shipment. One large producer of this item cleaned up his supply the early part of last week, the old contract price of 8@9½c. per lb. prevailing, and is now out of the market. *H* acid is listed as high as $2.25 per lb. in very small quantities, while *paranitraniline* came up to $1.65 per lb. under pressure of extremely short supplies. *Cresol*, U.S.P., also in the same position, is quoted at 18@19c. per lb., against 16@18c. of the previous report. *Aniline oil* held firm at the former level of 34@45c. per lb., with considerable difficulty in locating supplies; the *salts* are better at 46@50c. than the previous report of 42@48c. per lb. Short supply brought about by recent heavy demand has sent all grades of *cresylic acid* up, 97-99 per cent, straw color, in drums, being $1.10@$1.20, against 95c.@$1.10 of last week; 95-97 per cent, dark, in drums, is $1@$1.05, against last week's price of 85c.@$1, while 50 per cent, first, is listed at 65@75c. per gal., which is 5c. better than previously reported.

Naval Stores

There has been no business heard of in the naval stores market during the week. Shortage in the primary market, coupled with a complete tie-up of coastwise shipping, has effectually paralyzed the New York market. An attempt was made to send material by rail to relieve this stringent condition, but hardly had the cars started rolling when the railroad strike was called, cutting New York completely off from the primary market. The complete output is being diverted to the export trade and some material is being sent inland by rail wherever conditions will permit. Rather than quote prices which have no meaning and which do not represent actual sales, figures have been placed in the table that have been obtained from producers and which it is generally understood will hold upon the arrival of material from the South.

Vegetable Oils

There was very little change in the general conditions of the vegetable oil market during the week, prices being

well maintained except in *linseed*, which fell off slightly in futures, $1.72 per gal. being asked for May-June delivery and $1.62 for July-December. The freight embargo has affected the former rise in *cottonseed*, which is now back at the former levels of 16@17c. per lb. for summer yellow and 21@23c. per lb. for winter yellow, with very little activity exhibited on the part of the buyers.

Miscellaneous Materials

Fluorspar — We are advised that 700 tons of gravel fluorspar has been sold for $25 per net ton, f.o.b. mines, southern Illinois, with no analysis guaranty, contracts reading "Fairview Washed Gravel Fluorspar." Also, 1,250 tons were sold at the same price and same shipping point with an average guaranty of 85 per cent calcium fluoride and not over 6 per cent silica, while a small tonnage was sold at the same point, packed in barrels, with no analysis guaranty, at $37.50 per ton. Producers in this territory are not desirous of accepting contracts for acid grades of fluorspar and have refused to make any quotations on these grades. During the past few weeks the demand has become more active, but a good many of the fluorspar companies are pretty well sold. It is asserted that they are holding a certain portion of their tonnage for an expected increase in price.

Quotations on *graphite* remained unchanged during the week. Mexican amorphous graphite is being sold at $55@$60 per short ton; Korean, 3¾c. per lb.; Madagascar, 9c.; Ceylon, 4¼@16c., according to quality.

Feldspar is still in a nominal position; material is piling up at the mill with no transportation facilities available. The price holds firm at $13.50@$18 per ton.

Chicago, Ill., April 28, 1920.

In any report of existing market conditions, full recognition must be given the abnormal state of affairs due to the transportation troubles of the past few weeks. The chemical industry, in common with most others, was affected in two ways, viz.: Inability of manufacturers to ship completed products and the additional time consumed in securing delivery on shipments in transit have materially increased the money burden which the producer has to carry; the great reduction in the volume of receipts in Chicago has produced almost famine conditions in many lines, and prices, when quoted, are either nominal or greatly inflated.

Today's reports are to the effect that the strike is a failure and that the railroads are operating at a high percentage of normal. Even if this is true, it will take a good while to untangle the physical tie-up of cars and longer to get dealers' stocks and users' reserve stocks back on a normal basis. Frequently exhausted stocks mean sky-high prices. Now, however, consumers apparently recognize the futility of attempting to do the impossible, and actual demand is about as light as supply. As a result, prices are stationary. This maintains the market on a sane basis for the resumption of trading when traffic begins to move. What few fluctuations have been noted are in an upward direction.

Heavy Chemicals

The alkali products continue to lead in demand and, while current quotations are nominal, there is no doubt that this line is getting stiffer every day. With makers all booked to capacity for months ahead and with local stocks exhausted, further advances seem probable. It being distinctly a sellers' market, quotations are above those of two weeks ago. *Caustic soda* is going on contract for future delivery at 6½@7c. in cars f.o.b. works. Producers report output hardly sufficient to cover contracts, so spots will be scarce and high for some time. *Soda ash* is nominally quoted at from 3½@4½c., average being about $3.85 per cwt. Some few small local transactions were recorded at about 4½c. per lb. Production of *bleaching powder* seems less than market requirements, drums are hard to get and transportation tied up. Current quotation for carloads at factory is 4@4½c. per lb. The same applies to *sal soda*, on which quotations are heard ranging from $1.35 per cwt., f.o.b. factory, to $1.60 per cwt. out of depleted stocks.

The market on various grades of *alcohol* goes through the motions of making quotations. There being practically no goods, they mean but little. *Ethyl* grade is quoted at $4.85@$5.50 per gal. for delivery "when possible," and current actual transactions range all the way from $6 to $8. The quotation on *methyl* remains unchanged at $3 per gal. for 190 proof. The same is true of *denatured* at $1 per gal. There is no definite market for *formaldehyde*, each sale being the subject of negotiation. Only small lots are changing hands, transactions being in the neighborhood of 65c. per lb.

Previously noted interest in *glycerine* continued, 26c. per lb. being current on c.p. grade. *Aqua ammonia*, held firm by producers at 8¼c. per lb., has been run up in spot transactions to above 10c. in some cases. This high price does not seem justifiable. *Sal ammoniac*, unchanged at 16c. per lb. for white granulated, remains in heavy demand. Old contracts for *chlorine* are now being covered by withdrawals. New contracts are offered at 8½@8¾c. per lb., while spots stand at about 8½c. Former firmness in *sodium nitrite* remains, today's price being 26c. per lb.

Acid stocks are practically exhausted. The long-continued weakness of these prices seems to have been corrected by the present shortage, and while no advances of moment are noted, it is believed that when conditions return to normal, existing quotations will be firmly maintained. Transactions in spots are so small as to be negligible, hence no prices are quoted at this time.

Coal-Tar Products

With shortages in crudes, intermediates and derivatives all more acute than ever before, and with all current transactions being influenced by conditions altogether abnormal, it seems useless to attempt to name prices on coal-tar products which are, at best, purely nominal. It is sufficient to say that, with makers of crudes sold up far in advance, the market bids fair to hold firm. The same is true of intermediates, with the added fact that holders of supplies are offering them, and in some cases closing sales, on excessive prices.

Vegetable Oils

The impossibility of securing goods is only equaled by the lack of buying interest, in vegetable oils, a combination which leaves a market almost wholly devoid of interest. With an uncertain future ahead on *linseed oil*, $2.05 per gal. is being quoted in barrels, f.o.b. Chicago, and $1.82½ in cars in bulk. These prices are practically the same as those of four weeks ago. Current quotation on *cottonseed oil* is, for crude, 17c. per gal., prime summer yellow, 18c. per gal., sellers' tanks. *Cocoanut oil* in sellers' tanks, f.o.b. coast, is quoted at 17¾c. for Manila grade, and *corn oil* in tanks for local delivery at 16c. In general, these quotations are nominal, there being but few actual transactions.

Flotation Oils—Naval Stores

Although Savannah price is down to $1.91 per gal. on *turpentine*, the local market has failed to follow, the price being maintained at $2.57 per gal. in barrels, $2.40 in cars. This is justified by the fact that Chicago stocks are completely exhausted and it has not yet been possible to secure local delivery on any of the recent shipments from the South. Jobbers are forced to trace their cars and, upon locating them in Hammond, Gary, East Chicago or wherever they may be resting, send motor trucks to bring the goods on into the city. Thus an enormous addition is put on the cost. It is a condition that may be relieved any day, at which time the price will drop materially. Consumers, aware of the facts, are buying only such supply as is their absolute immediate requirement. There being no supply of flotation oils, hence no trading, nominal quotations show no change from a fortnight ago. The same is true of rosin in the various grades.

Fertilizers

The very great curtailment of operations in the stock yards occasioned by the railroad troubles served to cut off both production and demand. Such quotations as are available are of no value as transactions are practically nil.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	—	$0.65 – $0.75
Acetone	lb.	$0.19 – $0.20	.21 – .22
Acid, acetic, 28 per cent	cwt.	3.50 – 4.00	4.00 –
Acetic, 56 per cent	cwt.	6.50 – 7.00	8.75 – 9.00
Acetic, glacial, 99½ per cent. arboy	cwt.	15.50 – 16.00	16.50 – 17.50
Boric, crystals	lb.	.14½ – .15½	.15½ – .16½
Boric, powder	lb.	.14½ – .15	.15 – .16
Citric	lb.	.85 – .86	1.17 – 1.18
Hydrochloric (nominal)	lb.	.08 –	.09 – .10
Hydrofluoric, 52 per cent	lb.	.12 – .12½	.14 –
Lactic, 44 per cent tech	lb.	.11 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P	lb.	—	4.00 –
Nitric, 40 deg	lb.	.06 – .07	.07½ – .08½
Nitric, 42 deg	lb.	.07½ – .08	.08½ – .09½
Oxalic, crystals	lb.	.55 – .57	.58 – .59
Phosphoric, Ortho, 50 per cent solution	lb.	.22 – .23	.24 – .25
Picric	lb.	.30 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.50 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	14.00 – 18.00	—
Sulphuric, 60 deg., drums	ton	—	—
Sulphuric, 66 deg., tank cars	ton	22.00 – 25.00	—
Sulphuric, 66 deg., drums	ton	35.00 – 40.00	—
Sulphuric, 66 deg., carboys	ton	36.00 – 40.00	—
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	32.00 –
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 – 30.00	34.00 –
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 –
Tannic, U. S. P	lb.	1.50 – 1.60	1.65 – 1.70
Tannic (tech.)	lb.	—	.60 – .90
Tartaric, crystals	lb.	—	.75 – .80
Tungstic, per lb. of WO	lb.	—	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 – 5.50	6.00 – 7.00
Alcohol, Methyl (nominal)	gal.	2.50 – 3.50	—
Alcohol, denatured, 188 proof (nominal)	gal.	—	1.00 – 1.05
Alcohol, denatured, 190 proof (nominal)	gal.	—	.98 – 1.02
Alum, ammonia lump	lb.	.04½ – .05	.05½ – .06
Alum, potash lump	lb.	.07½ – .08½	.09 – .09½
Alum, chrome lump	lb.	.17 – .18	.19 – .20
Aluminum sulphate, commercial (nominal)	lb.	.01½ – .02	.02½ – .03½
Aluminum sulphate, iron free	lb.	.02½ – .03	.03¼ – .03¾
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½ – .10¾	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.33 – .35	.35 – .40
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – .17½
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 – .16½	.17 – .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 – .13½	.14 – .14½
Ammonium nitrate	lb.	.08½ – .12	—
Ammonium sulphate	lb.	.07 – .08	.08½ –
Amylacetate	gal.	—	3.65 – 3.75
Arsenic, oxide, lumps (white arsenic)	lb.	—	.13½ – .14½
Arsenic, sulphide, powdered (red arsenic)	lb.	.23 – .24	—
Barium chloride (nominal)	ton	150.00 – 160.00	165.00 – 175.00
Barium dioxide (peroxide)	lb.	.21 – .23	.24 – .25
Barium nitrate	lb.	.10 – .11	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.03 – .03½	.05½ – .06
Bleaching powder (see calcium hypochlorite)		—	—
Blue vitriol (see copper sulphate)		—	—
Borax (see sodium borate)		—	—
Brimstone (see sulphur, roll)		—	—
Bromine	lb.	.85 – .90	—
Calcium acetate	cwt.	2.00 – 2.05	2.10 –
Calcium carbide	lb.	.04½ – .04½	.04¾ – .05½
Calcium chloride, fused, lump	ton	22.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium hypochlorite(bleaching powder)	cwt.	4.00 – 4.25	4.35 – 5.00
Calcium peroxide	lb.	—	1.50 – 1.70
Calcium phosphate, monobasic	lb.	—	.75 – .80
Calcium sulphate, pure	lb.	—	.25 – .30
Carbon bisulphide	lb.	.07 – .08	.09 – .10
Carbon tetrachloride, drums	lb.	.11 – .11½	.12 – .15½
Carbonyl chloride (phosgene)	lb.	—	.80 – 1.05
Caustic potash (see potassium hydroxide)		—	—
Caustic soda (see sodium hydroxide)		—	—
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.07½ – .08	.08½ – .09
Chloroform	lb.	.30 – .35	.36 – .38
Cobalt oxide	lb.	—	2.00 – 2.05
Copperas (see iron sulphate)		—	—
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	—	.65 – .70
Copper sulphate, crystals	lb.	.08½ – .09	.09 – .09½
Cream of tartar (see potassium bitartrate)		—	—
Epsom salt (see magnesium sulphate)		—	—
Formaldehyde, 40 per cent (nominal)	lb.	.38 – .40	.60 – .80
Glauber's salt (see sodium sulphate)		—	—
Glycerine	lb.	—	.24½ – .26
Iodine, resublimed	lb.	—	4.35 – 4.40
Iron oxide, red	lb.	—	.03 – .20
Iron sulphate (copperas)	cwt.	1.50 – 1.75	1.80 – 2.00
Lead acetate, normal	lb.	.14 – .14½	.15 – .18
Lead arsenate (paste)	lb.	.11 – .12	.13 – .17
Lead nitrate, crystals	lb.	—	.90 – 1.00
Litharge	lb.	.14 – .15	.15½ – .16
Lithium carbonate	lb.	—	1.50 –
Magnesium carbonate, technical	lb.	—	.12 – .14½
Magnesium sulphate, U. S. P	100 lb.	3.50 – 3.55	3.60 – 4.25
Magnesium sulphate, commercial	100 lb.	—	3.25 – 3.60
Nickel salt, double	lb.	.14 –	.15 –
Nickel salt, single	lb.	.16 – .17	.17½ –
Phosgene (see carbonyl chloride)		—	—
Phosphorus, red	lb.	.50 – .55	.60 – .65
Phosphorus, yellow	lb.	—	.35 – .37
Potassium bichromate	lb.	.36 – .37	.40 – .46
Potassium bitartrate (cream of Tartar)	lb.	.53 – .56	.57 – .58
Potassium bromide, granular	lb.	—	.85 – .90
Potassium carbonate, U. S. P	lb.	—	.85 – .88
Potassium carbonate, crude	lb.	.21 – .25	.26 – .28
Potassium chlorate, crystals	lb.	.14 – .16	.21 –
Potassium hydroxide (caustic potash)	lb.	.28 – .29	.30 – .35
Potassium iodide	lb.	—	3.35 – 3.60
Potassium nitrate	lb.	.19 –	.21 –
Potassium permanganate	lb.	—	.65 – .95
Potassium prussiate, red	lb.	$0.90 – $1.00	$1.05 –
Potassium prussiate, yellow	lb.	.32 – .36	.38 – $0.41
Potassium sulphate (powdered)	ton	$225.00 – 240.00	—
Rochelle salts (see sodium potas. tartrate)		—	—
Salammoniac (see ammonium chloride)		—	—
Sal soda (see sodium carbonate)		—	—
Salt cake	ton	28.00 – 32.00	—
Silver cyanide (nominal)	oz.	—	1.25 –
Silver nitrate (nominal)	oz.	—	.74 – .76
Soda ash, light	100 lb.	—	3.50 – 3.60
Soda ash, dense	100 lb.	—	3.55 – 3.65
Sodium acetate	lb.	.08½ – .09	.09½ – .10
Sodium bicarbonate	100 lb.	2.25 – 2.60	2.75 – 3.00
Sodium bichromate	lb.	.39 – .41	.42 – .43
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 10.00
Sodium bisulphite Powered	lb.	.06 – .06½	.07 – .07½
Sodium borate (borax)	lb.	.09 – .10	.10½ –
Sodium carbonate (sal soda)	100 lb.	1.60 – 1.80	1.80 – 2.00
Sodium chlorate	lb.	—	.12 – .14
Sodium cyanide, 96-98 per cent	lb.	.24 – .25	.26 – .27
Sodium fluoride	lb.	.18 –	.19 – .20
Sodium hydroxide (caustic soda)	100 lb.	4.50 – 5.50	7.00 – 7.50
Sodium hyposulphite	lb.	—	.03 – .04
Sodium molybdate	lb.	2.50 –	3.25 –
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.22 – .24	.24 – .25
Sodium peroxide, powdered	lb.	.32 – .35	.35 – .40
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	.39 – .40	.40 – .41
Sodium prussiate, yellow	lb.	.23 – .2	.30 – .40
Sodium silicate, solution (40 deg.)	lb.	.01½ – .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.04 – .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.50 – 1.70	1.75 – 2.00
Sodium sulphide, crystal, 60–62 per cent (conc)	lb.	.09 – .10	.10½ – .11
Sodium sulphite, crystals	lb.	.03½ –	.04 – .06
Strontium nitrate, crystals	lb.	.23 – .24	.25 – .26
Sulphur chloride	lb.	.05¼ –	.06 –
Sulphur, crude	ton	22.00 –	—
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	3.35 –	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	3.20 –	3.30 – 3.40
Tin bichloride (stannous)	lb.	.42½ –	.46 – .50
Tin oxide	lb.	.60 – .63	.65 –
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.13 –	.13½ – .15
Zinc cyanide	lb.	.49 –	.50 – .60
Zinc dust	lb.	.12½ – .12½	.13 – .15
Zinc oxide, U. S. P	lb.	.18 – .19	.20 – .21
Zinc sulphate	lb.	.03½ – .03¾	.04 – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00 — $1.10
Alpha naphthol, refined	lb.	1.40 — 1.60
Alpha naphthylamine	lb.	.40 — .50
Aniline oil, drums extra	lb.	.34 — .45
Aniline salts	lb.	.46 — .50
Anthracine, 80% in drums (100 lb.)	lb.	.90 — 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 — 2.10
Benzidine, base	lb.	1.25 — 1.35
Benzidine, sulphate	lb.	1.20 — 1.25
Benzoic acid, U.S.P.	lb.	.90 — 1.10
Benzoate of soda, U.S.P.	lb.	.80 — 1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27 — .36
Benzol, 90%, in drums (100 lb.)	gal.	.25 — .31
Benzyl chloride, 95-97%, refined	lb.	.35 — .40
Benzyl chloride, tech	lb.	.25 — .35
Beta naphthol benzoate	lb.	.50 — .65
Beta naphthol, sublimed	lb.	.70 — .90
Beta naphthol, tech	lb.	.45 — .55
Beta naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 — .19
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.10 — 1.20
Cresylic acid, 95-97%, dark, in drums	gal.	1.00 — 1.05
Cresylic acid, 50%, first quality, drums	gal.	.65 — .75
Dichlorbenzol	lb.	.08 — .10
Diethylaniline	lb.	1.40 — 1.50
Dimethylaniline (nominal)	lb.	—
Dinitrobenzol	lb.	.30 — .37
Dinitroclorbenzol	lb.	.25 — .30
Dinitronaphthaline	lb.	.45 — .55
Dinitrophenol	lb.	.34 — .36
Dinitrotoluol	lb.	.40 — .45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine (nominal)	lb.	.55 — .65
H-acid (nominal)	lb.	2.25 — 2.50
Metaphenylenediamine	lb.	1.15 — 1.80
Monochlorbenzol	lb.	.12 — .15
Monoethylaniline	lb.	1.70 — 1.85
Naphthaline crushed, in bbls. (250 lb.)	lb.	.15 —
Naphthaline, flake	lb.	.15 —
Naphthaline, balls	lb.	.15 —
Naphthionic acid, crude	lb.	.70 — .85
Nitrobenzol	lb.	.14 — .19
Nitro-naphthaline	lb.	.40 — .50
Nitro-toluol	lb.	.20 — .30
Ortho-amidophenol	lb.	3.75 — 4.25
Ortho-dichlor-benzol	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.80 — 1.25
Ortho-nitro-toluol	lb.	.25 — .40
Ortho-toluidine	lb.	.25 — .45
Para-amidophenol, base	lb.	2.50 — 3.50
Para-amidophenol, HCl	lb.	2.50 — 3.25
Para-dichlor-benzol	lb.	.08 — .12
Paranitraniline	lb.	1.65 —
Para-nitro-toluol	lb.	1.35 — 1.50
Paraphenylenediamine	lb.	2.60 — 3.00
Paratoluidine	lb.	2.00 — 2.50
Phthalic anhydride	lb.	.65 — .75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 — .25
Pyridin	gal.	2.00 — 2.50
Resorcin, technical	lb.	4.25 — 4.50
Resorcin, pure	lb.	6.25 — 6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.50 — .52
Salicylic acid, U. S. P.	lb.	.55 — .60
Salol	lb.	.90 — 1.00

Solvent naphtha, water-white, in drums, 100 gal.	gal.	$0.25	—	$0.31
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	—	.24
Sulphanilic acid, crude	lb.	.25	—	.30
Toluidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.28	—	.....
Toluol, in drums	gal.	.29	—	.32
Xylidine, drums, 100 gal.	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal.	gal.	.37	—	.45
Xylol, commercial, in tank cars	gal.	.23	—	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.38	—	$0.39
Beeswax, refined, light	lb.	.40	—	.41
Beeswax, white pure	lb.	.63	—	.68
Carnauba, No. 1, (nominal)	lb.	.80	—	.88
Carnauba, No. 2, regular (nominal)	lb.	.60	—	.70
Carnauba, No. 3, North Country (nominal) †	lb.	.45	—	.46
Japan	lb.	.21	—	.22
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.....	—	.09¼
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.....	—	.09¾
Paraffine waxes, refined, 118-120 m.p.	lb.	.....	—	.11½
Paraffine waxes, refined, 128-130 m.p.	lb.	.....	—	.13½
Paraffine waxes, refined, 133-135 m.p.	lb.	.14	—	.15
Paraffine waxes, refined, 135-137 m.p.	lb.	.16	—	.16½
Stearic acid, single pressed	lb.	.26	—	.27
Stearic acid, double pressed	lb.	.32	—	.29
Stearic acid, triple pressed	lb.	.32	—	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.65
Pine oil, pure, dest. dist.	gal.	.....
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.38
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

*Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$16.95	—	$18.75
Rosin E-I	280 lb.	18.75	—	19.00
Rosin K-N	280 lb.	19.00	—	21.00
Rosin W. G.-W. W.	280 lb.	20.50	—	21.50
Wood rosin, bbl.	280 lb.	15.50	—	18.50
Spirits of turpentine	gal.	.....	—	2.50
Wood turpentine, steam dist.	gal.	2.35	—	2.46
Wood turpentine, dest. dist.	gal.	.....	—	2.00
Pine tar pitch, bbl.	200 lb.	8.40	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	15.00
Retort tar, bbl.	500 lb.	15.00	—	15.50
Rosin oil, first run	gal.	.92	—	.95
Rosin oil, second run	gal.	.94	—	.97
Rosin oil, third run	gal.	1.00	—	1.05
Rosin oil, fourth run	gal.	1.10	—	1.15

* (See New York market letter)

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.	.31½
68-70 deg., steel bbls. (85 lb.)	gal.	.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23½

Crude Rubber

Para—Upriver fine	lb.	$0.40½	—	$0.42
Upriver coarse	lb.	.30½	—	.32
Upriver caucho ball	lb.	.32½	—	.33
Plantation—First latex crepe	lb.	.44	—	.45
Ribbed smoked sheets	lb.	.44½	—	.....
Brown crepe, thin, clean	lb.	.42	—	.....
Amber crepe No. 1	lb.	.40½	—	.41½

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.18½	—	$0.20
Castor oil, AA, in bbls.	lb.	.20	—	.23
China wood oil, in bbls.	lb.	.24	—	.24½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.18½	—	.19½
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.20	—	.21
Corn oil, crude, in bbls.	lb.	.17½	—	.18
Cottonseed oil, crude (f.o.b. mill)	lb.	.16	—	.17
Cottonseed oil, summer yellow	lb.	.18½	—	.19
Cottonseed oil, winter yellow	lb.	.21	—	.23
Linseed oil, raw, car lots	gal.	1.84	—	.....
Linseed oil, raw, tank cars	gal.	1.79	—	.....
Linseed oil, boiled, car lots	gal.	1.87	—	.....
Olive oil, commercial	gal.	2.75	—	3.00
Palm, Lagos	lb.	.15½	—	.16½
Palm, bright red	lb.	.14½	—	.17½
Palm, Niger	lb.	.14	—	.17½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.22	—	.23
Peanut oil, refined, in bbls.	lb.	.25	—	.26
Rapeseed oil, refined in bbls.	gal.	1.62	—	1.64
Rapeseed oil, blown, in bbls.	gal.	1.68	—	1.70
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.17	—	.18
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.14	—	.14½

FISH

Winter pressed Menhaden	gal.	$1.17	—	$1.18
Yellow bleached Menhaden	gal.	1.20	—	1.22
White bleached Menhaden	gal.	1.23	—	1.24
Blown Menhaden	gal.	1.34	—	1.36

† (See New York market letter)

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$38.00	—	$40.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.04½	—	.05½
Blanc fixe, pulp	ton	30.00	—	50.00
Casein	lb.	.15	—	.18
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.04½	—	.06
Chalk, English, dense	lb.	.04	—	.05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar (nominal) f.o.b. N. Y. State	ton	13.50	—	18.00
*Fluor spar, acid grade, lump, f.o.b. Tonuco, N. ex	net ton	30.00	—	45.00
*Fluor spar, acid grade, ground, f.o.b. Tonuco	net ton	55.00	—	65.00
Fuller's earth, domestic, powdered	ton	25.00	—	30.00
Fuller's earth, imported, powdered	ton	35.00	—	40.00
Graphite, crucible, 85% carbon content	lb.	.....	—	.07½
Graphite, crucible, 86% carbon content	lb.	.....	—	.08
Graphite, crucible, 87% carbon content	lb.	.....	—	.08½
Graphite, crucible, 88% carbon content	lb.	.....	—	.09
Graphite, crucible, 89% carbon content	lb.	.....	—	.09½
Graphite, crucible, 90% carbon content	lb.	.....	—	.10
Graphite, crucible, 91% carbon content	lb.	.....	—	.10½
Graphite, crucible, 92% carbon content	lb.	.....	—	.11
Graphite, crucible, plus 92%	lb.	.....	—	.12½
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	.....
Shellac, orange, fine, nominal	lb.	1.50	—	.....
Shellac, orange, superfine	lb.	1.60	—	1.65
Shellac, A. C. garnet	lb.	1.30	—	1.35
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	20.00	—	30.00
Talc, imported	ton	60.00	—	70.00

*Nominal

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	$75-80 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	45-50 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	40-45 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-85 at Chester, Penn.
Silica brick	1,000	50-55 at Mt. Union, Penn.

Ferro-Alloys

All Prices f.o.b. works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20	—	.21
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.21	—	.22
Ferro-manganese, 70-80% Mn	gross ton	200.00	—	250.00
Spiegeleisen, 16-20% Mn	gross ton	60.00	—	65.00
Ferro-molybdenum, per lb. of Mo	lb.	2.25	—	2.75
Ferro-silicon, 50%	gross ton	80.00	—	90.00
Ferro-silicon, 75%	gross ton	150.00	—	200.00
Ferro-silicon, 10-15%	gross ton	60.00	—	65.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.90	—	1.10
Ferro-uranium, 35-50%, of U	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50	—	7.75

Ores and Semi-finished Products

All Prices f. o. b. Mines

Chrome ore, 35-40%, Cr_2O_3	unit	$0.70	—	$0.85
Chrome ore, 48% and over	unit	1.00	—	1.25
Coke, foundry, f.o.b. ovens	net ton	12.00	—	14.00
Coke, furnace, f.o.b. ovens	net ton	11.00	—	12.00
Petroleum coke, refinery, Atlantic seaboard	net ton	.....	—	14.00
Fluor spar, gravel, f.o.b. mines	net ton	25.00	—	30.00
Manganese ore, 45% Mn and over	unit	.75	—	.85
Manganese ore, chemical (MnO_2)	gross ton	80.00	—	90.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00	—	10.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50	—	7.50
Uranium oxide, 96%	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Pyrites, foreign, lump	unit	.17	—	.....
Pyrites, foreign, fine	unit	.17	—	.....
Pyrites, domestic, fine	unit	.16	—	.17½
Ilmenite, 52% TiO_2	lb.	.02	—	.....
Rutile, 95% TiO_2	lb.	.11	—	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free	lb.	.10	—	.....
Monazite, per unit of ThO_2	unit	42.00	—	.....

Structural Steel

Mill, Pittsburgh

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.65
Rivets, structural, ½-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ½-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.85
Sheets, No. 10 blue annealed	100 lb.	4.00
Sheets, No. 28 galvanized	100 lb.	6.20

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

SALINAS—The Bd. Educ. plans to build a 2-story high school here. A chemical laboratory will be installed in same. Wyckoff & White, archts.

Connecticut

MIDDLETOWN — Henry Bacon, 101 Park Ave., New York City, archt. and engr., will receive bids until May 23 for the construction of a 2-story chemical laboratory for the Wesleyan University. 374 High St. Estimated cost, $500,000. Noted March 10.

District of Columbia

WASHINGTON—The Bureau of Yards & Docks, Navy Dept., plans to build an aëronautical engine-testing laboratory.

Illinois

CHICAGO—The Columbia Colortype Co. is building a 6-story, 123 x 177-ft. building on the northeast corner of Calumet Ave. and 21st St. Estimated cost, $600,000. R. C. Wieboldt, 1534 West Van Buren St., contractor.

KEWANEE—The Kewanee Boiler Co. has awarded the contract for the construction of plant extensions including new 80 x 1,750-ft. buildings, to the Lackawanna Bridge Co.

Iowa

CUSHING—The city has awarded the contract for the construction of a sewage disposal plant to Ward & Weighton, 516-17 Davidson Bldg., Sioux City, at $10,995.

DANA—The Bd. Educ. will receive bids until May 17 for the construction of a 2-story, 56 x 86-ft. consolidated school building. A chemical laboratory for general work will be installed in same. Estimated cost, $100,000. Guy Meredith, secy. W. E. Hulse & Co., 210 Masonic Temple, Des Moines, archts.

DES MOINES—The Dempster Mfg. & Supply Co., 201 East Court Ave., has awarded the contract for the construction of a 1-story, 120 x 180-ft. foundry and machine shop on East Court Ave., to A. H. Neumann & Co., 519 Hubbell Bldg. Estimated cost, $100,000.

GILMAN—The School Bd. is having preliminary plans prepared for the construction of a 2-story consolidated school. A chemical laboratory will be installed in same. Estimated cost, $100,000. R. J. Paul, pres. Keffer & Jones, 204 Masonic Temple, Des Moines, archts.

GOWRIE—The Bd. Educ. is having preliminary plans prepared for the construction of a 3-story, 65 x 100-ft. school building. A general chemical laboratory will be installed in same. Estimated cost, $125,000. Clarence Strand, secy. Keffer & Jones, 204 Masonic Temple, Des Moines, archts.

MEDIAPOLIS—The Bd. Educ. is having preliminary plans prepared for the construction of a 3-story consolidated school. A chemical laboratory will be installed in same. Estimated cost, $160,000. J. E. Berry, secy. Keffer & Jones, 204 Masonic Temple, Des Moines, archts.

MORNING SUN—The Bd. Educ. will receive bids until May 8 for the construction of a 2-story, 56 x 130-ft. school building. A general chemical laboratory will be installed in same. Estimated cost, $200,000. O. F. Beller, secy. W. E. Hulse & Co., 210 Masonic Temple, Des Moines, archts.

PACKWOOD—N. E. Olliver, secy. of the Bd. Educ., will receive bids until May 7 for the construction of a 2-story, 58 x 99-ft. school building. A general chemical laboratory will be installed in same. Estimated cost, $125,000. W. E. Hulse & Co., 210 Masonic Temple, Des Moines, archts.

YARMOUTH—The Bd. Educ. is having preliminary plans prepared for the construction of a 3-story consolidated school. A chemical laboratory will be installed in same. Estimated cost, $100,000. C. C. Featherby, secy. Keffer & Jones, 204 Masonic Temple, Des Moines, archts.

Kansas

OSAWATOMIE—The Missouri Pacific Ry. plans to build a modern water treating plant, here. Estimated cost, $61,700.

Kentucky

LOUISVILLE—The Stoll Oil Refining Co., 733 River Road, will build a 1-story, 44 x 60-ft. filter house and is in the market for filter house machinery, etc. Work will be done by day labor.

Maryland

BALTIMORE—C. M. Anderson, arch., 324 North Charles St., will soon award the contract for the construction of a 3-story, 61 x 76-ft., addition to tinware enameling and stamping plant for the Natl. Enameling & Stamping Co., Race and Ostend Sts. Estimated cost, $100,000.

CURTIS BAY (Baltimore P.O.)—The Union Acid Wks. have awarded the contract for the construction of a 2-story, 200 x 500-ft. acid plant on Aspin and Railroad Aves., to the Whiting-Turner Constr. Co., Stewart Bldg., Baltimore. Estimated cost, $200,000. Noted Jan. 14.

HAGERSTOWN—The Washington Co. School Comrs., Courthouse, are having plans prepared for the construction of a high school. A chemical laboratory will be installed in same. Estimated cost $150,000. R. E. Staley, 247 South Prospect St., supt. A. J. Klinkhart, 54 West Washington St., archt.

Massachusetts

CAMBRIDGE—The Lever Bros. Co., Portland St., has awarded the contract for the construction of a 6-story, 90 x 190-ft. factory for the manufacture of soaps, to the Stone & Webster Eng. Corps., 147 Milk St., Boston. Estimated cost, $350,000.

CHELSEA—Leon E. Gingras, 156 Marginal St., has awarded the contract for the complete remodeling of tannery building on Marginal St., to Tuck & Gilman, 34 School St., Boston. Estimated cost, $65,000.

HOLYOKE—The Hampden Glazed Paper & Card Co., Riverside, has awarded the contract for the construction of a 2-story manufacturing plant, to the Casper Ranger Constr. Co., 2 Bond St. Noted May 4.

NATICK—The New England Pressed Steel Co. has awarded the contract for the construction of a 1-story, 55 x 85 ft. factory addition, to A. Jensen Co., Sawin St. Estimated cost, $25,000. Noted March 31.

WEST SPRINGFIELD (Springfield P. O.)—McClintock & Craig, engrs., 33 Lyman St., Springfield, will soon award the contract for the construction of a 1-story, 90 x 200-ft. factory for the manufacture of electrical specialties, for the Wico Electric Co., 44 Avon Place. Estimated cost, $75,000. Phelps Brown, pres.

Michigan

MARYSVILLE—The village is having plans prepared for the construction of a semi-permanent water supply system consisting of pumping station, filtration plant, etc. Estimated cost, $200,000. Robert Gordon, engr.

Minnesota

FOREST LAKE—The Bd. Educ. plans to install a chemical laboratory in the new high school here. Foss & Foss, St. Cloud, archts.

JAMESVILLE—The village will receive bids until May 7 for the construction of a sewage dispoal plant consisting of an Imhoff tank, etc. R. R. Brown, village recdr.

OLIVIA—The Bd. Educ. is having plans for the construction of a 2-story high school here. A chemical laboratory will be installed in same. Estimated cost, $185,000. W. L. Alban, Endicott Bldg., St. Paul, archt. Terry Schulte Eng. Co., Endicott Bldg., St. Paul, engr. Bonds have been voted for the project.

SACRED HEART — The Independent School Dist. 40 rejected all bids for the construction of a 2-story high school here. A chemical laboratory will be installed in same. W. L. Alban, 347 Endicott Bldg., St. Paul, archt. Terry Schulte Eng. Co., 484 Endicott Bldg., St. Paul, Engr.

Missouri

ST. LOUIS—W. R. Coney & Co., New York City, have purchased the plant of the Mutual Brewery Co. on the northeast corner of Boyle and Duncan Aves., here, and plan to convert same for bleaching and coloring materials.

ST. LOUIS—The Crunden Martin Mfg. Co., 21st and Gratiot Sts., plans to build a 6-story factory building on the southeast corner of 2nd and Cedar Sts. The building will be used to house a manufacturing plant for galvanized enamel ware. Estimated cost, $500,000.

ST. LOUIS—The General Electric Co., Pierce Bldg., is building a plant for the manufacture of electric light bulbs on the corner of Union and Brown Aves. Estimated cost, $300,000.

Nevada

FALLON—The Humboldt Potash Co. plans to construct a large chemical plant, here. The plant will operate on potash from the extensive deposits in the Dixie Valley. The New York Syndicate has secured control of 36,000 acres in the Dixie Valley and plans to build first unit of plant on same.

New Jersey

NEWARK—The Amer. Brake Shoe Co., 30 Church St., New York City, has awarded the contract for the construction of a 1-story foundry on Ave. L between Mary and Paris Sts., to James Stewart, 30 Church St., New York City. Foundry equipment will be installed in same. Estimated cost, $400,000.

New York

BUFFALO—The Amer. Brass Co., Grand and Meadow Sts., Waterbury, Conn., will build a 165 x 650-ft. rolling mill at 446 Military Rd. Estimated cost, $600,000. Work will be done by day labor.

BUFFALO—The Dept. of Pub. Wks. received bids for the delivery of 80,000 lb. of liquid chlorine from the Mathieson Alkali Wks., Inc., 25 West 43rd St., New York City, $5,920; Electric Bleaching Gas Co., 18 East 41st St., New York City, $5,920; Hooker Electrochemical Co., 25 Pine St., New York City, $5,968. Noted April 14.

BUFFALO—The Donner Union Coke Corp., Abbey and Bell Sts., has filed plans to construct a 1-story, 8 x 28 x 31-ft. steel laboratory and a 1-story, 15 x 17 x 26-ft. first aid building. Estimated cost, $10,000.

BUFFALO—The General Drop Forge Co. has awarded the contract for the construction of a 1-story, 60 x 100-ft. forge shop and a 1-story, 100 x 100-ft. heat treating plant, to J. C. Cowper Co., Fidelity Bldg. Estimated cost, $200,000.

GREYCOURT—The Comr. of Correction, Municipal Bldg., will receive bids until May 7 for the furnishing of all labor and material for the construction of a sewage disposal plant for the New York City Women's Farm Colony, here.

JAMAICA—The A. L. Read Co., Jamaica Ave. and 121st St., Richmond Hill, has awarded the contract for the construction of a 2-story, 70 x 125-ft. leather factory, to Barney Ahlers, 110 West 40th St., New York City. Estimated cost, $75,000.

LONG ISLAND CITY—The Elcaya Co., 148 Madison Ave., New York City, plans to build a 4-story laboratory on First St. between Reeve and Freeman Aves., here.

LONG ISLAND CITY—S. L. Reily, archt. and engr., 112 West Adams St., Chicago, Ill., will soon award the contract for the construction of a 4-story factory for the manufacture of oil products, for the P. Van Iderstine Construction Co., Greenpoint Ave.

SYRACUSE—The M. L. Oberdorfer Brass Co., 804 East Water St., has awarded the contract for the construction of a brass factory at Messina Springs, to the A. & T. Constr. & Eng. Co., 115 South Salina St. Estimated cost, $500,000. Noted Feb. 25.

North Carolina

CHERRYVILLE—The Cherryville Foundry Wks. has plans prepared for the construction of a foundry for the manufacture of gray iron castings. C. C. Dellinger, prop.

North Dakota

MCVILLE—The Council has awarded the contract for furnishing a concrete septic tank, etc., to Gedney & Murphy, Fargo, at $25,877. Noted April 21.

Ohio

CANTON—The Superior Sheet Steel Co. plans to build a 1-story 120 x 500-ft. steel building on Louisville Rd. Estimated cost, $200,000.

CLEVELAND — The city will soon award the contract for the construction of a filtration plant, etc., at Baldwin. Estimated cost, $200,000. A. V. Ruggles, City Hall, engr. Noted March 23.

WARREN—The Warren Iron & Steel Co. is having plans prepared for the construction of a 1-story, 120 x 300-ft. rolling mill. Estimated cost, $150,000. Watson Eng. Co., Hippodrome Bldg., Cleveland, archt. and engr.

Oklahoma

HENRYETTA — C. A. Strecker, Oklahoma City, plans to remodel plant recently purchased here and equip it with the Duwell process for refining gasoline, naphtha and kerosene.

PRYOR—The city voted $35,000 bonds to improve waterworks, including purification plant, etc. V. V. Long & Co., Colcord Bldg., Oklahoma City, engr.

TULSA—The Oklahoma Steel Castings Co. has purchased a 9½-acre site west of Pearl St. and south and east of the Santa Fe R.R. Company's main line and plans to construct a plant on same. The company will manufacture steel castings of either acid or basic steel for the oil industry, etc. Estimated cost, $100,000. Clarence B. Douglas, mgr.

Pennsylvania

JEANETTE—The Amer. Window Glass Co., Farm Bank Bldg., Pittsburgh, is having plans prepared for the construction of a 1-story, 42 x 182-ft. building.

PITTSBURGH—The McKenna Brass & Mfg. Co., 1st and Ross Sts., plans to build a 4-story, 53 x 80-ft. addition to present plant. Estimated cost, $175,000. James T. Steen & Sons, Fulton Bldg., archts.

ROCHESTER—The H. C. Fry Glass Co. has awarded the contract for the construction of a 1-story, 80 x 200-ft. glass factory to the Austin Co., Union Arcade, Pittsburgh. Estimated cost, $110,000.

Rhode Island

PAWTUCKET—The Fales & Jenks Machine Co., 320 Dexter St., has awarded the contract for the construction of a 3-story, 45 x 80-ft. manufacturing building addition on Pine St., to Willmarth Mackillop, Inc., Freeman St. Estimated cost, $50,000.

South Carolina

GREENWOOD—The Bd. Educ. plans to build a 3-story college for women. A chemical laboratory will be installed in same. Estimated cost, $100,000 T. W. Cothran, contg. engr.

Texas

BASTROP—The city will soon receive bids for the construction of a 2-story, 58 x 60-ft. high school. A chemical laboratory will be installed in same. Estimated cost, $30,000. H. F. Kuehne, 824 Littlefield Bldg., Austin, archt.

DALLAS—The Eastland Oil & Refining Co., Security Natl. Bank Bldg., is having plans prepared for the construction of a lubricating unit to oil refinery, including equipment for refining oil and preparing lubricating oil as one of the products. Estimated cost, $350,000. H. P. Williford, 3501 Harvard Ave., engr.

DALLAS—The School Bd. is having plans prepared for the construction of a 3-story high school on Haskell and McKinney Sts. Chemical laboratory equipment will be installed in same. Estimated cost, $250,000. W. B. Ittner, Bd. Educ. Bldg., St. Louis, Mo., archt.

MEMPHIS—The Memphis Cotton Oil Co. will soon receive bids for rebuilding main building which was recently destroyed by fire and installing new machinery in same. Estimated cost, $200,000

MERCEDES—The Independent School Dist. is having plans prepared for the construction of a 1-story, 157 x 217-ft. high school here. A chemical laboratory will be installed in same. Estimated cost, $75,000. H. F. Kuehne, 824 Littlefield Bldg., Austin, archt.

NECESSITY (Caddo P.O.)—The Alamo Refining Co., Eastland, plans to purchase a 5-acre site and build a plant on same. The plant will be built on a unit basis. J. R. Evans, mgr. G. B. Dartois, chief engr.

West Virginia

CLARKSBURG—The Bd. Educ. will soon award the contract for the construction of a junior high school. A chemical laboratory will be installed in same. J. N. Hess, Empire Bank Bldg., secy.

Wisconsin

KENOSHA—Allen Sons Co., North Main St., is having plans prepared for the construction of a sewage disposal plant. Estimated cost, $50,000. Vaughn & Meyer, Security Bldg., Milwaukee, engrs.

SHEBOYGAN FALLS—C. S. Weisse Tanning Co. will build a 3-story, 84 x 248-ft. tannery on Buffalo St. Estimated cost, $150,000. Work will be done by day labor. Noted April 21.

ST. CROIX FALLS—The Bd. Educ. engaged W. L. Alban, archt., 347 Endicott Bldg., St. Paul, to prepare plans for the construction of a 2-story, 53 x 90-ft. high school, here. A chemical laboratory will be installed in same. Estimated cost, $75,000. F. R. Nash, principal.

Ontario

ELMIRA—The city plans to construct a sewerage system. Septic tanks will probably be installed in same. Estimated cost, $30,000. H. Johnston, Kitchener, engr.

TORONTO—The Barrett Co., 17 Battery Pl., New York City, has awarded the contract for the construction of a roofing factory, to James Stewart, 30 Church St., New York City. Estimated cost, $400,000.

Coming Meetings and Events

THE AMERICAN ASSOCIATION OF ENGINEERS will hold its sixth annual convention at the Planters Hotel in St. Louis, May 10 and 11.

THE AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

THE AMERICAN CHEMICAL SOCIETY, N. Y. Section, will hold regular meetings on May 7 and June 11, at the Chemists' Club.

THE AMERICAN DROP FORGE ASSOCIATION will hold its seventh annual convention at the Marlborough-Blenheim Hotel, Atlantic City, N. J., June 17, 18 and 19.

THE AMERICAN ELECTROPLATERS' SOCIETY will hold its eighth annual convention in Rochester, June 30 to July 3. Headquarters will be at the Seneca Hotel.

THE AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its semi-annual meeting in Montreal, June 21 and 22; Ottawa, June 23; Shawinigan, June 24 and 25, and La Tuque, June 26.

THE AMERICAN IRON AND STEEL INSTITUTE will hold its spring meeting May 28 at the Hotel Commodore, New York City.

THE AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

THE AMERICAN SOCIETY OF REFRIGERATING ENGINEERS will meet in St. Louis May 27 to 29.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its annual meeting at Asbury Park, N. J., June 22 to 25.

THE AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18, inclusive.

THE AMERICAN ZINC INSTITUTE will hold its spring meeting May 10 and 11 at the Congress Hotel, Chicago, Ill.

THE CHEMICAL SOCIETY OF THE COLLEGE OF THE CITY OF NEW YORK announces the following lectures for the spring semester of 1920 to be delivered in the Doremus Lecture Theater: "Chemical Naval Warfare," Friday, May 7, at 4 p.m., Prof. James Kendall, professor of chemistry at Columbia University; "Fighting Fire—Firefoam," Friday, May 14, at 4 p.m., F. A. Epps, chief engineer, the Foamite Firefoam Co. (*Experimental, cinema and lantern.*)

THE INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA plans to hold its annual convention in the Auditorium Theater, Chicago, Ill., May 19, 20 and 21.

THE INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

THE IRON AND STEEL INSTITUTE (London) will hold its annual meeting May 6 and 7, 1920, at the House of the Institute of Civil Engineers, Great George St., London, S. W. 1. The retiring president, Eugene Schneider, will induct into the chair Dr. J. E. Stead, the president-elect. The autumn meeting of the Iron and Steel Institute (British) will be held at Cardiff, by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

THE MINE INSPECTORS' INSTITUTE OF AMERICA will hold a meeting at Cleveland, Ohio, July 13, 14 and 15.

THE SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in the Grand Central Palace, New York City, Sept. 20 and 25.

THE NATIONAL FERTILIZER ASSOCIATION will hold its twenty-seventh annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 21.

THE NATIONAL FOREIGN TRADE CONVENTION will be held in San Francisco, May 12 to 15. Chinese delegates have chartered the S. S. Ecuador for transportation to this conference.

THE NEW JERSEY CHEMICAL SOCIETY plans the following: Monday evening, May 10, regular meeting; Saturday afternoon and evening, June 5, at Rutgers College, New Brunswick, N. J., regular meeting and ladies' day.

THE SOCIÉTÉ CHIMIE INDUSTRIELLE will hold a meeting at the Chemists' Club, May 14.

THE SOCIETY OF COTTON PRODUCTS ANALYSTS will hold its eleventh annual conventoin at the Grunewald Hotel, New Orleans, La., May 10 and 11.

THE SOCIETY OF CHEMICAL INDUSTRY, American Section, will hold a meeting, May 21, at the Chemists' Club.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION will hold its twenty-seventh annual meeting June 29 to July 3, at the University of Michigan, Ann Arbor, Mich.

THE TAYLOR SOCIETY, the national organization for the promotion of scientific management in industry, will hold a meeting May 6, 7 and 8 at Rochester, N. Y., under the auspices of the Industrial Management Council and the Manufacturers' Council of the Rochester Chamber of Commerce.

Industrial Notes

HOLZ & Co., metallurgical engineers and dealers in testing equipment, announce the organization of a filtration department. The new department, under the management of Frank H. Lowenfels, is prepared to supply or prepare specifications for all types of laboratory and plant filtration equipment. In connection with this service, a complete line of Franklin filter paper will be placed on the market.

THE B. F. GOODRICH RUBBER CO. has equipped the grain elevator of the Pennsylvania R.R. at Canton, near Baltimore, with approximately 8½ miles of conveyor belting. This represents the largest single order of belting ever shipped, and it required seven box cars to transport it from Akron to Baltimore. The belting totaled 44,254 ft. and weighed 131 tons. The capacity of one of the 48-in. horizontal carrier belts is 350,000 bushels of grain in a 10-hr. day.

THE MATHIESON ALKALI WORKS, INC., announces that it is handling direct the sales of all its products, and that the executive and general sales offices have been moved from Providence, R. I., to 25 West 43d St., New York City.

THE ST. LOUIS DRUG AND CHEMICAL CLUB has been formed in St. Louis, Mo., with 100 charter members.